THE BOOK OF THE AUTOMOBILE

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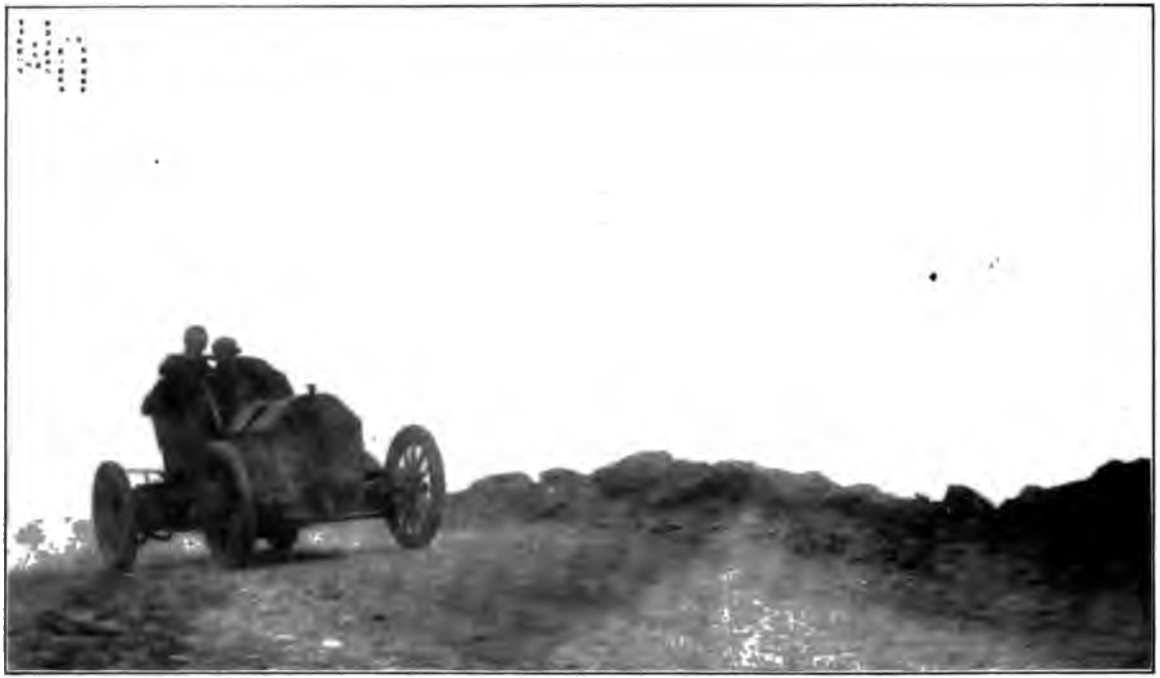

Courtesy of *The Automobile.*

OUT OF THE CLOUDS.

Harry Harkness within fifty feet of the finish of the Mount Washington eight-mile hill-climb, July 12, 1904.
Time, 24 min. 37$\frac{3}{5}$ sec.

THE BOOK
of the
AUTOMOBILE

A Practical Volume Devoted to the History Construction, Use and Care of Motor Cars and to the Subject of Motoring in America

By

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Introduction by

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INTRODUCTION

The automobile is the latest achievement of that general movement throughout history which has for its object the annihilation of space by man. To conquer distance has been one of the great problems of life. From his creation man has struggled to harness the forces of nature; but down to the last century he has been seriously fettered and his development mercilessly hampered by his limitations. Man wants physical individual transportation. The steamboat and the railroad have partially accomplished this; they carry their hundreds of thousands of passengers daily. But while man may go in them to the ends of the world, he can not go subject to his own volition alone; he must go with others, as one of a thousand, as one of a herd. The more one thinks of these conditions, the more one is forced to the humiliating realization that in the method and control of individual transportation there has been practically little advance since the days of the Greek runner or the Roman chariot. We marvel at modern invention, and we pity the condition of our early ancestors; yet we still plod along at the same old rate of eight miles an hour, a speed equaled from the beginning of history by runners, horses, dromedaries, and elephants. At

last the automobile has been invented. Let us hope it will emancipate us from the fetters that have bound us these thousands of years, and that it will soon carry us over the entire face of the earth, annihilating space and time at our will. No power on earth can take its place, unless it be the invention of successful air-ships.

That the automobile is part of the world's progress, and has come to stay was at first neither understood nor appreciated by the public in America—a country where new ideas and inventions are usually readily appreciated and eagerly exploited. Let me cite a few instances of the way the metropolis of America—the center of brains and wealth in this country—met the new idea. The city authorities insisted that the steam automobile was technically a locomotive, and required, therefore, that a guard be sent a hundred feet in advance, waving a red flag to warn the unprotected populace of its approach. Unsuccessful in this method of "regulating" the new "monster," they adopted another plan, which, though a farce in practise, they seriously enforced. A rule was passed that all steam automobiles should be inspected by the appropriate city department, and that no one should operate such a machine without an engineer's license. At first it was thought impossible to get around this order, as an engineer's license could be obtained only after several years' apprenticeship as a fireman. But in America, foolish and obnoxious laws which are contrary to

the spirit of fair play are always evaded or disobeyed. Accordingly it was discovered that a little city on the Hudson had different license requirements, a mild examination and the payment of a small fee being all sufficient. As between nations, so between cities, the spirit of comity prevails; the applicant presented the certificate of the little city to the officials of the big city, and after a perfunctory examination of what a boiler was, how steam was generated, and what should be done to put the fire out, was duly recognized by them as an engineer.

The following was still another method devised to harass automobiles: The Park Commissioners decided that the parks were meant for horse-drawn vehicles and children, and that as the admission of the automobile would be a menace to their safety, it should be entirely excluded. The numbers of automobilists had now become so large and their influence so great, however, that they no longer felt the necessity for evading this rule. They boldly notified the authorities of their intention to disregard it, and, in company with witnesses and attorneys, a few zealots "forced" an entrance into the sacred precincts. Evidently a change of spirit had come over those in power, for the defiant pioneers sped unmolested by policeman after policeman, and on their triumphant return lodged a complaint against the officers for not arresting them! These instances, taken at random from many examples, serve to illustrate the point. This same intolerance

was shown by all other cities, and everywhere it was a fight, with no quarter given or asked. It did not dawn in the minds of any one not an automobilist that the automobile had legal rights, was entitled to consideration, or was destined to become an important part of street traffic. Even now, though automobiles crowd our streets, there still remains a vicious desire to exterminate them.

How shall we explain this attitude? Let us be fair and point out that some of the automobilists themselves are, unfortunately, partially to blame. Some drivers of the automobile regard it in the light of a toy to furnish amusement in speeding and racing on the highway. So regarded, it is truly a nuisance, a menace to life, and no legitimate means of street locomotion. Further, nearly every man has his mind directed to many abuses which are continually advertised by the yellow journals to increase their circulation. He hears that a millionaire has ordered a 120 H. P. machine, costing $20,000, to beat the record of another millionaire, and that fortunes are spent with impunity by the rich on these space-devouring monsters, just for the fun of speeding. He reads that Mr. So-and-So, when giving bail, tossed a hundred-dollar bill to some clerk, afterward forgetting to have the money refunded. All these and other highly colored and sensational stories, mostly untrue, influence his imagination, and when he is forced by a drunken or reckless automobilist to jump for his life, it is but natural that he should nurse hatred against the man

whose toys cost more than he can earn in a lifetime. Chauffeurs have even a worse reputation than their rich masters. They are accused of doubling their normal salaries by dishonest commissions, letting out for hire the machines in their charge, deliberately injuring the engines in drunken sprees with their friends, speeding so as to get arrested and divide the owners' fine with the deputies, and a dozen other crimes that should send them to the penitentiary.

Although these facts may excuse the unthinking public for their intolerant attitude, the misusers of the automobile are in reality few, and they are repudiated as reckless, unreasonable, and irresponsible by all right-minded people, automobilists or otherwise. These rash ones, by their rash deeds, obscure the vital reason for their existence and so tend to bring the automobile movement into disrepute. But their vicious influence is not confined to automobiling, it is felt wherever their presence intrudes. It accompanies their every action, and makes them equally objectionable in every other sphere of activity. If their past should be investigated, it will be found that their record in every department is tainted with the same inconsiderate conduct which has made them obnoxious in the automobile world. It is therefore manifestly unfair to include them in that class of men who are worthy to be known as automobilists, for by such they are repudiated.

Happily, the notorious rich who spend fortunes

on high-powered machines and the dishonest chauffeurs whose careers always end in discredit have only a superficial, though harmful, influence on the general development of the industry. Their number is necessarily limited and their influence affects a different sphere from the one in which lies the real future of the automobile. That is in the machine which the general public can afford to buy and use in its daily occupations just as to-day it utilizes the horse and carriage.

The problem of the automobile is a serious one. It is daily becoming more serious because people are attacking it from the wrong standpoint. This is due largely to ignorance on the part of both autophobist and reckless and unthinking devotee, the one desiring extermination, the other unbridled license. When once both sides admit that prohibition is impossible, unreasonable, and uncommercial, and that fair regulation is possible, profitable, and *necessary,* the problem will no longer exist. As yet there has been no honest desire or attempt to discover the proper place of the automobile in our civilization, each side being solely engaged in fighting the other to the death, regardless of merit or sound sense. Perhaps this is natural; the automobile in actual use in America is barely six years old, and the rapid strides the manufacturers have made in its development have not permitted any "proper place" to be found for it in our daily life. Improvements and changes have come so fast, one on another. that each year of its existence has almost

produced a new machine, thus preventing adequate conception of its proper sphere by obscuring the basic truth underlying the situation.

Moreover, it is impossible at this early age for any one to know what its ultimate functions are. We can only study its present and speculate as to its future. In connection with this, it is interesting to glance at the history of the bicycle. At first the price was high and the wheel unreliable; then there were few roads fit for it. By gradual development into a low-priced and trustworthy machine, its use on the part of the public became general, and it acquired national importance. It was the cause of the first great impetus to the good roads movement; in the city asphalt replaced nerve-racking cobbles, and throughout the country we were given at least navigable roads between the chief centers. The automobile has started out in the same way, and is pursuing the same trend, but its influence is bound to be still more radical and thorough. The price is being lowered so that soon a machine will cost but little more than an ordinary horse and carriage, with several times their efficiency and radius. Machines are no longer made in helter-skelter fashion, each different from the next, but models and parts are standardized, broken or worn-out engines are made over without inconvenience. Though not yet perfected, the automobile is at least commercially reliable. Express companies, department stores, and other business institutions, recognizing this, as well as its great radius and endurance, are

changing from horses to the horseless vehicle. It is coming more and more into universal service. In the city its general use must cause the disappearance of the horse. The city is no fit place for that most useful animal, and when he is forced out of it, the most strenuous autophobist will reluctantly admit that with him has gone all the dirt and disease he now causes, and that the narrow streets' capacity for traffic is quadrupled, since the automobile takes up half as much room and can go with equal safety twice as fast. In the country the impetus to good roads resulting from its introduction has already been enormous. Through its influence bills have been introduced in Congress for a national highway from the Atlantic to the Pacific, and the State of New York has already once passed the necessary bill for a constitutional amendment for a fifty-million-dollar bond issue to provide good roads throughout the entire State. Undoubtedly the present legislature will again pass the bill so that at the next election the amendment may be presented to the people.

The general use of the automobile has opened up a new sphere for young men, or, according to Bernard Shaw, has produced "the new man." Intelligent, resourceful young fellows who previously could find no outlet for their mechanical bent, and could barely earn from $50 to $60 a month, have suddenly had opened to them a field which is practically without limit, and which may serve as a stepping-stone to better and larger things. The

Young Men's Christian Association of New York City has realized the importance of this opportunity, and, aided by The Automobile Club of America, has established a school for scientific instruction in both the theory and practise of automobiling. The first course has only just been finished, and I understand the results are well beyond expectations. Applicants for the new term number over two hundred, and it is felt the effort is filling a great need. It is certainly gratifying that such is the case, because the old idea, that any one who can push a lever and draw a salary is a chauffeur, no longer prevails. In spite of any popular conviction to the contrary, every applicant for the position of chauffeur knows that to succeed he must be not only intelligent, honest, sober, and full of "horse-sense," but also a competent machinist, with the instincts of a gentleman in the best sense of the word.

Strange to say, the stanchest advocate of the automobile to-day is the farmer. He has appreciated much more quickly than the city man the advantages of the machine, probably because these advantages appeal to him in a peculiar way. He has been taken out of an otherwise enforced loneliness; farms which have heretofore been inaccessible, both for their occupants and for their products, have, by the introduction of the automobile, overcome space, and found new and near neighbors. Where it took a farmer all day to drive his horse to market, sell his goods and return home, he can now

do it in a morning, besides carrying twice the load he did before. He likewise appreciates that in addition to their larger radius, automobiles have the further advantage of requiring neither to be fed nor cooled off, expensive and time-consuming processes.

In bringing these introductory remarks to a close, I wish to emphasize strongly that the automobile problem must be approached by a dispassionate discussion of the situation, so that opinions may not be merely the result of unfortunate experience reenforced perhaps by the unjudicial "dicta" of some of our judges on the bench. What is wanted is anything which will make people think rightly about the automobile and give them correct ideas of its history, its use, and the place to which modern life should assign it. It is hoped the present book will do this and will suitably guide the awakened interest of the public in the solution of the many problems presented by the necessary regulation and control of the automobile. I trust that something I have said in relation to approaching these problems in a proper spirit will appeal to legislators, the public, and automobilists alike, and that in consequence there will result a better understanding, a feeling of greater confidence, and a mutual respect, on the part of all interested in the future of the automobile.

DAVE HENNEN MORRIS,
President of the Automobile Club of America.

NEW YORK, *March 30, 1905.*

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THE BOOK OF THE AUTOMOBILE

CHAPTER I

BEGINNINGS

FROM the earliest dawn of intelligence man seems to have pictured in imagination a means of unlimited individual locomotion.

Toward the end of the thirteenth century the learned Franciscan friar, Roger Bacon (1214–'94), wrote: "We will be able to propel carriages with incredible speed without the assistance of any animal." Bacon evidently was gifted with a pretty correct scientific imagination, for, in the same breath, he predicted steamships and flying-machines.

It is apparently not till the seventeenth century that we find the imagined horseless carriage first "bodied forth" by one Johann Haustach, of Nuremberg, described as a "manufacturer of chariots going by spring and making 2,000 paces an hour." The illustration shows Herr Haustach with his hand on the lever, controlling the coiled spring which served as motor. There was evidently no steering

device, so that this dignified and elaborate chariot was only able to travel in a straight line.

About this same period wind-driven vehicles (*seylende windwagen*), a kind of ship on wheels, were used on the flat plains of Holland. In 1619

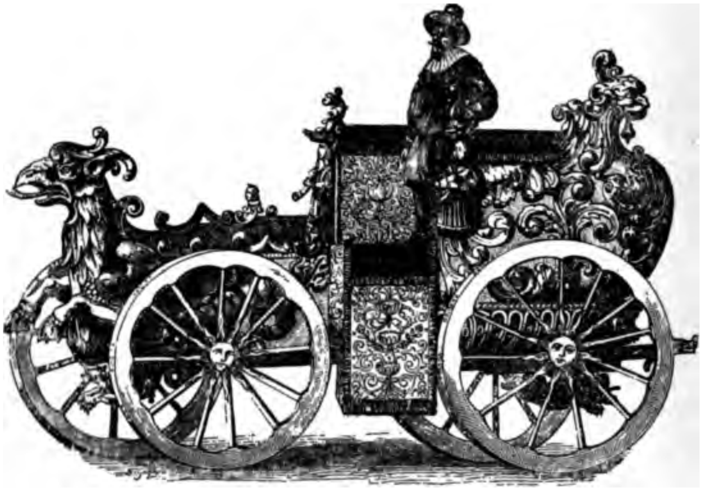


FIG. 1.—A CLOCKWORK CHARIOT OF THE SEVENTEENTH CENTURY.

an English patent granted to Ramsey and Wildgoose included "drawing-carts without horses." In 1644 a patent of Louis XIV granted to "Jean Theson the privilege of employing a little four-wheel carriage set in motion without any horses, but merely by two men seated." These were probably foot-propelled vehicles. As late as 1748 one Vaucanson, in the presence of Louis XV, drove "a carriage with clockwork springs."

The idea of applying steam to the propulsion of road-vehicles arose with the invention of the steam-

engine. Its development was contemporary with that of the steam railroad for a time, till the latter finally forced it into the background, there to remain until recent years.

Sir Isaac Newton is said to have constructed, in 1680, a model of a steam-carriage, the motor of which was simply an application of the old original steam-engine of Hero of Alexandria, invented in 200 B. C. Newton's model was propelled by the reac-

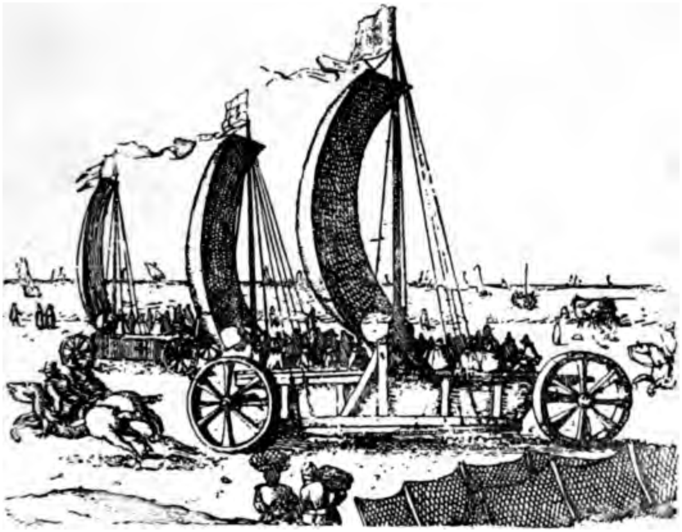


FIG. 2.—DUTCH SAIL WAGONS, SEVENTEENTH CENTURY.

tionary force, or "kick," of a jet of steam escaping from a nozzle in the rear.

Newton's application of steam did not comprehend the transmission of power by suitable gearing, and in this it was inferior to that of Giovanni

Branca, who in 1629 invented a steam-turbine, which he used for the grinding of drugs. Father

FIG. 3.—THE FIRST STEAM-ENGINE, 200 B. C.

Verbiest, a missionary at Pekin, China, is said to have forestalled Newton, and set up a steam-jet and vaned-wheel arrangement similar to Branca's en-

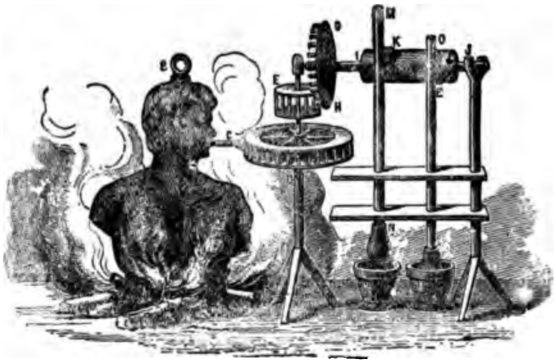


FIG. 4.—BRANCA'S STEAM-TURBINE, 1629.

gine. This he applied to a road-carriage of light construction, which it propelled by means of a vertical shaft geared to one of the axles.

To France, however, belongs the distinction of inventing the first steam-automobile. In 1769 Nicholas Joseph Cugnot, with state funds placed at his disposal by the Duc de Choiseul, constructed a steam gun-carriage. The following year he built another and better one, which is still preserved in Paris.

Cugnot's trolley had but three wheels. The boiler overhung in front, on the theory that its weight would be counterbalanced by the load on the carriage. The engine was placed behind the boiler

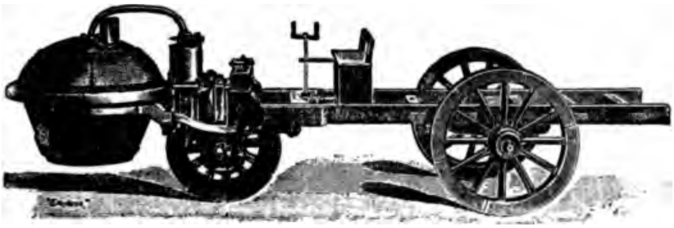


FIG. 5.—STEAM GUN-TROLLEY OF NICHOLAS CUGNOT, 1769.

and consisted of two 13-inch single-acting cylinders. The movement of the pistons was transmitted to the axle of the driving-wheel by two ratchet-wheels (*G*, Fig. 6) connected to it. The piston-rods (*D*) acted on these for a quarter of a revolution by means of the crank *F*. The engine could be reversed at will. The driving-wheel could be swiveled by means of steering-gear. This road-engine of Cugnot's proved its ability to carry a load of two and a half tons at a speed of three miles per hour. Napoleon Bonaparte caused the appointment of a Commission of the Institute to investigate the invention, but the

Revolution quickly put a stop to any further development of it in France.

It was in England that the first substantial development of the steam-carriage took place. It is said that in 1759 Dr. John Robinson suggested a steam-propelled vehicle to James Watt, the reputed inventor of the steam-engine. Later Dr. Erasmus

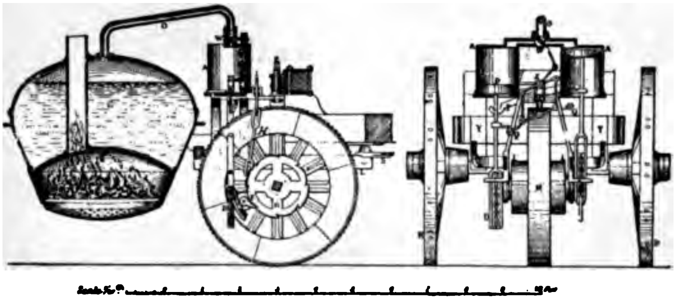


FIG. 6.—BOILER AND DRIVING MECHANISM OF CUGNOT'S TROLLEY.

H, chain drawn down by crank *F*, and raising opposite piston *P* by means of lever *I*; *Q Q*, levers operating four-way cock *W* for admission and exhaust; *Q Q* are actuated by projections on piston-rods *D*.

Darwin did likewise, and even dropped into poetry, for which he had a weakness, thus:

> "Soon shall thine arm, unconquered steam, afar
> Drag the slow barge, and drive the rapid car."

Watt did not encourage these suggestions, though he himself patented, in 1784, an invention for propelling vehicles by steam. His pupil, William Murdock, however, in 1781 constructed a model which his vicar described as "a fiery little devil," after Murdock one dark night had nearly frightened the life out of that pious gentleman with it.

Two Americans, Oliver Evans, of Maryland, in 1787, and Nathaniel Read, of Massachusetts, in

FIG. 7.—MURDOCK'S "FIERY LITTLE DEVIL," 1781.

1790, invented steam road-wagons. Evans's was a combined boat and road-wagon.

Richard Trevithick in 1802 patented a steam-carriage in England, in which a distinct advance

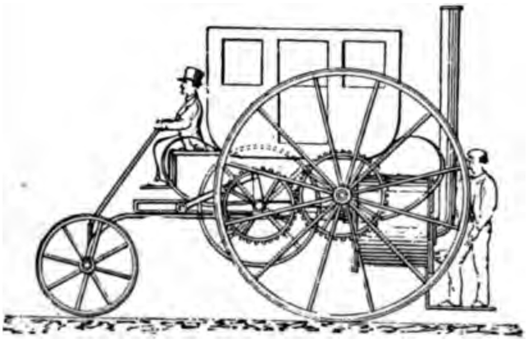


FIG. 8.—TREVITHICK'S STEAM-CARRIAGE, 1802.

was made by gearing the crank-shaft with the driving-wheels. About this time the fallacy was

commonly entertained that ordinary wheels were insufficient to secure traction, and many curious systems of propulsion by mechanical legs were invented. That of David Gordon, patented by him

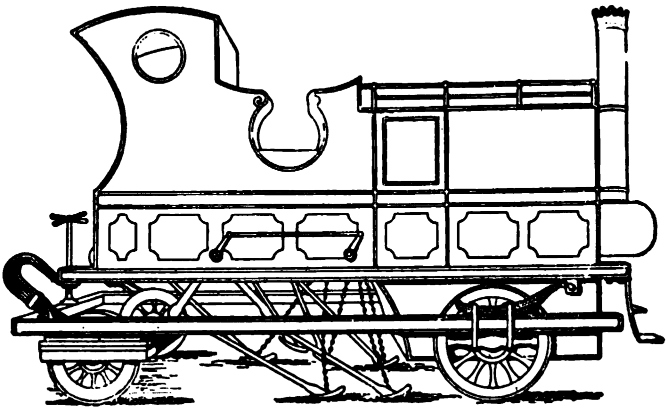


FIG. 9.—GORDON'S PATENTED TRACTION BY MECHANICAL LEGS, 1824.

in 1824, was applied by its inventor to a steam-carriage.

Among the numerous experiments in the early part of the nineteenth century the names of Gurney and Hancock are found as those of the most successful developers of the steam road-vehicle. Sir Goldsworthy Gurney began work in 1822, constructing his first six-wheeled coach with propelling legs, to be brought into use in hill-climbing, and at other times when it was feared the wheels would not furnish sufficient traction. Gurney soon found this precaution unnecessary, however—a fact which Trevithick had previously demonstrated. Sir Charles Dance established a regular service with

Gurney's coaches between Gloucester and Cheltenham, nine miles, running-time three-quarters of an hour, making four trips daily. The service was continued for four months in 1831, and then abandoned on account of ignorant opposition and popular prejudice.

Gurney was anticipated slightly by Walter Hancock, who was the first to put a steam-omnibus on the road in 1829. Hancock's work was greatly in advance of any of his contemporaries. He invented and used upon his coaches a high-pressure boiler,

Fig. 10.—One of Gurney's First Coaches with Auxiliary Legs, 1822.

which proved itself to be the most efficient of the period. He was the first to apply to a motor-vehicle chain-transmission of power, and he invented the "wedge" type of wheel construction.

Hancock gave all his coaches names, the oddest of which was "The Autopsy." It did not, however, fulfil the omen of its name, for with four others it ran in regular service between Stratford and Pad-

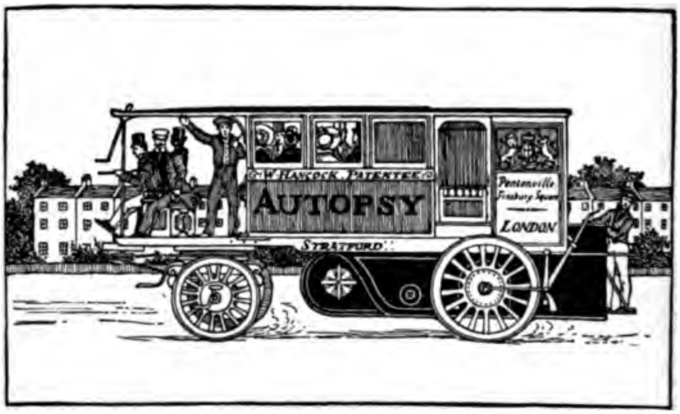


FIG. 11.—HANCOCK'S "AUTOPSY," 1836.

dington in 1836, carrying in twenty weeks 12,760 passengers, and covering safely 4,200 miles.

The achievements of Gurney and Hancock and their contemporaries (such as Dr. Church, J. Scott Russel, the constructor of the Great Eastern steamship, and F. Hills, inventor of the differential balance-gear) did scarcely more than suggest the problems involved in the construction of self-propelled vehicles. Their work really belongs to the evolution of the steam railway, the successful development of which was largely instrumental, in England, in checking the advance of the self-propelled road-vehicle. Popular prejudice, aroused by a few accidents, was fomented by the railroad companies, who

regarded the automobile as a serious rival. As a result, in 1836 Parliament passed the Locomotives Act, imposing prohibitive tolls and restrictions on steam road-vehicles. This law was not repealed till August 15, 1896, and practically put a stop to the construction of the motor-carriage in England for over half a century.

We must turn to France for advance in automobile construction subsequent to 1840. Since the steam-carriage of Cugnot, only a few sporadic attempts are recorded until Amédée Bollée, of Mans, exhibited two steam-carriages at the Paris Exposition of 1878. Two years later he built the omnibus "La Nouvelle," which in the famous race from

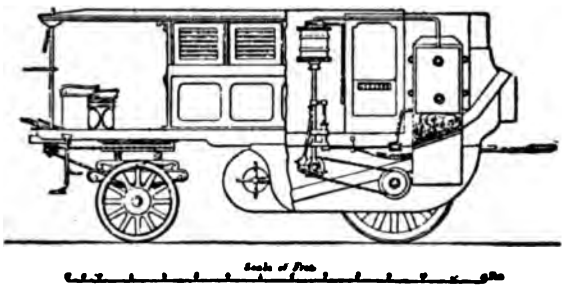


FIG. 12.—GENERAL PLAN OF HANCOCK'S COACHES, SHOWING CHAIN TRANSMISSION.

Paris to Bordeaux in 1895, covered 745 miles in 90 hours, 3 minutes.

In 1888 Léon Serpollet first applied his newly invented "flash" boiler to a tricycle, and then to a four-seat car which was run in Paris. Serpollet's boiler, instead of storing water and steam, gener-

and steam instantaneously by pumping a sufficient quantity of water into superheated tubes, where it was "flashed" into steam directly to the engine cylinder. The same year (1888) Count Albert de Dion, Georges Bouton, and Trépardoux constructed a steam-tricycle. These inventions were the foundations for great and rapid advance in the construction of small high-pressure engines for road-carriages.

The great impetus to automobile construction proper came, however, with the successful application of the gas engine to road-vehicles, by two Germans, Gottlieb Daimler and Carl Benz, independently, in 1886. Daimler, who was manager of the Otto Gas Engine Works at Deutz, fitted his small, air-cooled motor to a bicycle. In 1889 he constructed a two-cylinder engine which attracted the notice of Messrs. Panhard & Levassor, of Paris. They acquired the necessary rights, and began immediately the construction of what was essentially the modern motor car. They were quickly followed by Peugeot Frères. Benz's small motor was water-jacketed, and was first applied by him to a three-wheeled car. He subsequently developed it in collaboration with Roger, of Paris.

Automobile construction now made rapid strides in France, and the Paris-Rouen meet of 1894 and the Paris-Bordeaux run of 1895 demonstrated to the world that the efficient, self-propelled road-vehicle had arrived. It is hardly too much to say that from this time on the history of automobilism

is epitomized in the history of the various clubs and associations of those interested in the automobile chiefly as a means of pleasurable locomotion. The oldest and most influential of these is, of course, the Automobile Club of France, which sprung, in 1895, from the permanent commission into which the committee in charge of the famous Paris-Bordeaux run had been organized. The chairman of this committee was the Baron de Zuylen. The first meeting of the committee had been held November 18, 1894, at the house of the Marquis de Dion, who at the Paris-Rouen contest had just achieved the highest average speed, 12 miles an hour, in a steam-carriage, his own invention. The first prize was divided between MM. Panhard and Peugeot, who drove gasoline vehicles with 3½ horse-power Daimler motors. In the race of 1895 M. Levassor on a Panhard car covered the distance of 730 miles at the rate of nearly 15 miles per hour. Six years later the same course was covered by Panhard cars and others at the rate of over 50 miles an hour. M. Panhard, in 1894, laughed at a prophecy of this achievement. Unfortunately he did not live to see it.

The work of the Automobile Club of France has been chiefly the promotion of races and competitions and of the annual automobile show in Paris, all of which have been exceedingly valuable in furnishing demonstrations of the capabilities of motor-vehicles.

In the summer of 1895 a 4 horse-power Panhard

car was brought into England by Mr. Evelyn Ellis. He and Sir David Salamons in October, 1895, gave a demonstration at Tunbridge Wells, where the capabilities of a Panhard and a Peugeot car and a de Dion steamer were exhibited to Members of Parliament and others whom it was desirable to interest in the repeal of the Locomotives Act. On November 14, 1896, the Light Locomotives Act, originally brought forward by Mr. Henry Chapman, became law, opening English roads to the automobile. About twenty cars celebrated the day by a run from London to Brighton, and the following year the Daimler Motor Company placed automobiles of English manufacture upon the market. On the 10th of August, 1897, the Automobile Club of Great Britain and Ireland was organized, and has since been an active force in overcoming popular prejudice, which is even stronger against the automobile in Great Britain than in this country. The club is a recognized authority on automobilism in Great Britain.

In America, as elsewhere, there had been for many years attempts by different inventors to build horseless carriages, and they were more or less successful. Most of them, however, employed steam, so that their efforts are of less importance than those of experimenters far-sighted enough to believe that the gasoline-motor was destined to be the automobile-motor of the future. A Mr. Fawcett, of Pittsburg, built an omnibus in 1878 in which he employed a Brayton motor, essentially a slow-speed

affair and therefore not adapted to the light modern vehicle. How successful this omnibus was it is impossible to say, but it is of interest because of the prominence of the Selden patent, which was evidently an attempt to show the Brayton motor in an automobile.

During the '80s a Mr. Copeland brought out a bicycle equipped with a steam-motor, and later he built two tricycles similarly equipped. These were the predecessors of the light steam-vehicles. Descriptions of them and their doings were published in the trade-papers, and, while inventors and mechanics were interested, the public gave the matter no thought, and, for lack of capital, Mr. Copeland's devices disappeared from view. The bicycle equipped was made by the H. B. Smith Machine Co. In the late '80s they built a steam-tricycle.

In 1886 Mr. Charles E. Duryea, while employed near it, observed a gasoline-engine, electrically ignited, and decided that such an engine could be made light, simple, and compact enough to propel a horseless carriage better than anything then known. He began studying and experimenting, as opportunity permitted, toward this end. In 1888 he assisted, in an advisory capacity, in partly constructing a light buggy, driven by a 2-horse-power steam-engine, but this work was stopped by the death of the designer. During 1891 he made drawings and began the work on a gasoline-vehicle. His brother, Mr. J. F. Duryea, was closely associated with him in this work. Their first vehicle was completed in the lat-

ter part of 1892. It was decidedly underpowered, like most first vehicles, and an attempt to rebuild it indicated that many of the parts were lighter than they should be if more power was added. A third attempt, using the same design with heavier parts, was made, and the car was finished in the fall of '93. This vehicle is shown in Plate I. Not only it, but also the first one, embodied all the essential features of the modern automobile, lacking only in quality. They had cylinders lengthwise of the body, which gives the least vibration. They had C steering-knuckles, and were driven through bevel-gear differential counter-shaft by double chains to the rear wheels. As first designed, they had friction transmission from the motor, but lack of experience caused failure to secure perfectly satisfactory results, although much driving was done with the friction arrangement. Because of lack of capital, it was decided to use a positive transmission and take up friction-drive later, when time and money permitted. Having demonstrated, by tests in the winter of 1892, that the geared transmission was satisfactory, the Duryeas at once began on a fourth design, using a two-cylinder two-cycle motor. This lacked flexibility, and late in 1894 a vehicle was completed with a four-cycle motor. After some slight changes this was put on the road in March, 1895. It was used almost daily the entire summer. It wore out its first set of solid tires in two or three months, and was then equipped with pneumatics, being the first motor-vehicle so equipped in the

I

FIRST GASOLINE AUTOMOBILE MADE IN AMERICA BY CHARLES E. DURYEA.

FIRST GASOLINE AUTOMOBILE MADE IN AMERICA BY ELWOOD T. HAYNES.

United States. It won the Chicago Times-Herald race in the fall of that year. The Duryea Motor Wagon Co. was then organized, and thirteen vehicles, the first regularly manufactured in the United States, were finished in the summer of 1896. Four of these were entered in the Cosmopolitan contest at New York in 1896, and three of them were the only vehicles to get back to the city the same day. The driver of one was arrested because a bicycle-rider, watching a baseball game, carelessly ran into him. During the same year two of these vehicles took part in the first English event, the London to Brighton run. The winning cars of the French race of that year, with the drivers who had skilfully piloted them into first, second, and third positions, had been brought over and were confidently expected to lead the way to Brighton. Great was the surprise when a yellow-wheeled Duryea car from a place well at the rear beat the French winners into Brighton by over an hour in the short distance of fifty-two miles.

The price of these early vehicles ($1,500) was considered very high for an untried substitute for the horse and buggy, and this, more than anything else, prevented rapid acceptance in America of the gasoline-automobile. During 1896–'97 Mr. George Whitney, of Providence, operated a light steam-vehicle very successfully, and Stanley Bros. with ample capital improved on this. The result was the light steam-car afterward known as the Locomobile. This performed beautifully, ran easily, and

was promised to the public at a very low price. Its subsequent vogue at home and abroad temporarily overshadowed the work being done in America by developers of the gasoline-machine.

In the mean time work was being done in the West by Mr. Elwood Haynes. He is said to have conceived the idea in 1888, but did not construct his first vehicle till 1893. This was finished and given a test on the road in July, 1894. It had no balance-gear and drove only on one rear wheel. The wheels were wire, with solid or cushion rubber tires, and the motor was a single-cylinder two-cycle launch-engine. Steering was by hand-crank acting on a vertical shaft. In the second vehicle put on the road in November, 1895, a short horizontal shaft was placed at the top of the vertical with another set of bevel-gears, so that the crank moved in a vertical plane, like a hand-organ crank. The Haynes-Apperson Co. was incorporated in 1898.

Alexander Winton made his first vehicle in 1896, adapting to his purpose, like Mr. Haynes, motors then on the market; but unlike him, Mr. Winton chose a stationary motor instead of a launch-motor. On this account the early Winton cars were very heavy. In 1899, with a half-dozen assistants, he was building automobiles in a rented one-room shop. To-day he owns one of the largest factories in the country. His efforts have done much to develop the automobile industry in America. The same may be said of Mr. R. E. Olds, who built a single vehicle in the late '80s, and also of Mr. Henry Ford, who

built one in 1893, and who both subsequently developed these early experiments in a way that has made them important factors in American automobile history.

The substantial beginning of the automobile movement in America was signalized by the organization, on June 7, 1899, of the Automobile Club of America, by a handful of enthusiasts, who elected Mr. George F. Chamberlain as their president. On November 4, 1899, the club organized its first run, a distance of scarcely seven miles, over good roads. Of the thirty-eight machines which attempted the journey, less than a dozen finished, the rest being balked by no greater obstacle than a grade on Riverside Drive, within the limits of New York City. At this time, only six years ago, there were but fifty cars in the whole of America. Now there is an average of one automobile for every 1,200 inhabitants of the United States, and there are upward of 25,000 automobilists in New York State alone.

The first American automobile show was held in Madison Square Garden in the fall of 1900, under the auspices of the Automobile Club, which had great difficulty to induce the management of the Garden to assume any portion of the financial risk of the exhibition. So few machines were being manufactured in this country at the time that the members of the club loaned their own machines to piece out the display. The second exhibition, the following year, was managed by a joint committee

of the club and of the American manufacturers, whose products covered the whole main floor of the Garden. For the fifth annual exhibition, held this year, the capacity of the Garden proved vastly inadequate, notwithstanding that the importers of foreign machines held a separate salon elsewhere, under independent management. Another year will probably see an additional exhibition by the Automobile Club along lines eliminating the commercial standpoint of the manufacturer.

The automobile had been in extensive use abroad for nearly five years before American designers seriously turned their attention to it; then it was to the production of the light car that their main effort was directed. Consequently they clung to the horizontal motor, which in their hands has reached a higher efficiency than it has attained abroad. Foreign makers have attained preeminence in the construction of the heavy, high-powered touring-car, with multiple-cylinder motor. This type necessarily appeals to a more limited class of purchasers than does the light runabout, which perhaps secures a larger profit to the manufacturer through sales to the middle class so extensive in this country. The Exhibition of 1905, however, shows great advance by American manufacturers in the production of the touring-car along the lines laid down by foreign manufacturers. About 18,500 American cars were built in 1904, with a total value of $22,000,000. In France, where there is Government record of every vehicle, there

are about 24,000 automobiles in use; in Great Britain, about 20,000; and in the United States, from 40,000 to 50,000. Exports from the United States for 1902 aggregated $874,986 worth of machines, while for nine months of 1904 the total was $1,445,986. Exports of automobiles from France, as computed by Mr. Arthur M. Jervis in Leslie's Magazine, February, 1905, show from January 1 to August 1, 1904, an increase of about 35 per cent over the same period of 1903; the imports of cars into France during the same period showed a gain of more than 350 per cent. Mr. Jervis based this calculation on official Government records. The figures are as follows: French exports, January 1 to August 31, 1902, $3,978,200; 1903, $7,295,000; 1904, $9,895,000. French imports, 1902, $119,800; 1903, $133,200; 1904, $471,400. Mr. Jervis also computes that, though there were more automobiles imported into this country in 1904 than in 1903, the increase in number of cars imported was in smaller ratio to the number of cars sold, all of which would indicate that American cars are becoming more popular at home, and, in the case of light cars, are invading the foreign markets.

CHAPTER II

THE GASOLINE–MOTOR

THE adaptation of the principle of the internal-combustion engine (invented by M. Beau de Rochas in 1862) to a compact motor capable of propelling road-vehicles, made possible the development of the modern automobile. Here was found the prime essential, a motive agent combining the maximum of power with the minimum of bulk and weight. Subsequent improvements have made it appeal so strongly to the motorist on the score of simplicity, reliability, ease of care and control, that it is now preeminent in automobile construction.

Until the invention of the gas-engine, steam was the only available means for utilizing the expansive energy of heat. In the steam-engine the heat energy of burning fuel converts the boiler-water into steam under pressure, and this is made to drive a piston back and forth in the engine-cylinder, the heat being thus simply transformed into work. Now 1 kilogram of coal (2.2 pounds) represents between 8,000 and 9,000 calories, equivalent to a pressure of 3,400,000 kilogrammeters, or to 11,-152,000 foot-pounds per pound of coal. A kilogram of gasoline represents 15,000 calories, 20,-

Courtesy of *Motor*.

MOTOR OF THE FLYING DUTCHMAN II.

Henry L. Bowden's 120 H. P. racing-car, which made the mile record of $32\frac{4}{5}$ seconds at Ormond Beach, Fla., January 31, 1905. The eight-cylinder motor consists of two 60 H. P. Mercedes motors—one taken from an ordinary car and the other from a launch.

913,636 foot-pounds per pound—nearly twice the calorific power of coal. Hence, theoretically, and in fact practically, the gasoline-motor should yield a higher efficiency than the steam-motor. The gasoline-motor derives the expansive energy directly from the fuel by internal combustion or explosion, propelling the piston in the cylinder, as a charge of gunpowder propels the projectile in a gun. In the early history of explosive-engine construction an attempt was actually made to utilize gunpowder as the motive agent. By dispensing with boiler and furnace, the gas-engine also secures a very high power-efficiency in proportion to its size and weight.

Internal-combustion engines, however, are single acting—that is, the power-impulse is applied to only one side of the piston, and drives it only in one direction. For its return-stroke the piston must depend upon its own momentum. This necessitates the attachment to the crank-shaft of a relatively heavy fly-wheel which stores the momentum of the piston, and enables it to make the return-stroke. The cylinder of a gasoline-motor is open at the end toward the crank-shaft and closed at the opposite end, forming a chamber for the admission of the explosive mixture, which is ignited automatically. Within the bore of the cylinder is fitted the gas-tight piston of the hollow or "trunk" variety, a cylindrical box in the center of which is hung the swinging connecting-rod combining the functions of piston-rod and connecting-rod as employed in the steam-engine. To start a steam-

engine it is only necessary, after getting up steam to the proper pressure, to open the throttle and admit the vapor to the cylinder. In the gasoline-motor, starting is accomplished by turning with

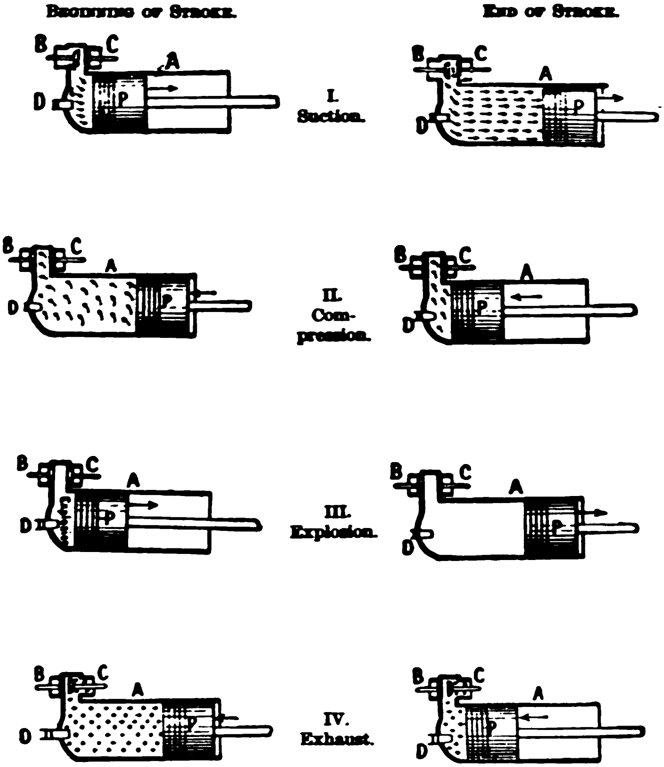


Fig. 13.—The Beau de Rochas or Otto Four-Part Gas-Engine Cycle.

the hand a crank on the driving-shaft, until the piston has been carried through a sufficient number of strokes to enable the motor to take up its " cycle." Fig. 13 illustrates the Beau de Rochas or Otto four-

stroke cycle, employed almost exclusively in automobile-motors. The first forward stroke of the piston (P) represented at *I* induces a vacuum in the cylinder, opening the inlet-valve (B) by suction, and thus admitting the explosive mixture. The crank and fly-wheel make half a revolution during this stroke. The piston is now at the bottom of the cylinder, and the inlet-valve (B) is closed automatically by means of a spring. The second (backward or return) stroke of the piston, shown at *II*, compresses the gas into the combustion chamber (the space between the top of the cylinder and the piston). This compressed gas is now ignited by the mechanically operated electric sparking-plug (D), and the explosion forces the piston forward on its third stroke, shown in *III*. The piston now returns on its fourth stroke, shown at *IV*, carried by its own momentum. As it does so, the exhaust-valve (C) is opened mechanically, and the burned gases are expelled, leaving the cylinder clear for the admission of fresh explosive mixture with the next inhaust-stroke. These four strokes of the piston, compassing two revolutions of the crank and fly-wheel, complete the cycle of the motor. The operations involved will be better understood from Fig. 14.

It is obvious that the expansive energy generated by firing the explosive charge in the combustion chamber must be great enough, not only to drive the car, but also to carry the piston through the three strokes during which there is no power-

impulse. By constructing a motor with more than one cylinder, and timing the explosions so that they occur at different instants, a power-impulse may be

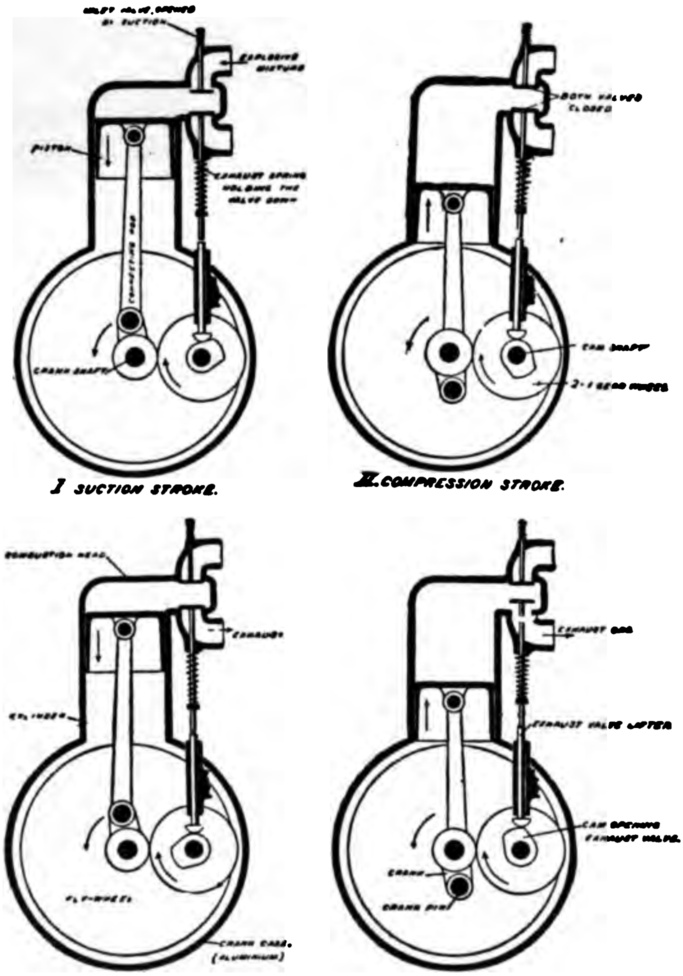


FIG. 14.—THE "CYCLE" OF A GASOLINE-MOTOR, SHOWN IN DETAIL.

secured more frequently. Thus a four-cylinder motor may be so arranged as to give a power-impulse once in every half-revolution of the fly-wheel, and if the cranks were set on the shaft at angles of 180° from each other the strokes in the different cylinders would take place contemporaneously. Fig. 15 represents such an arrangement, each piston being at the beginning of one of the

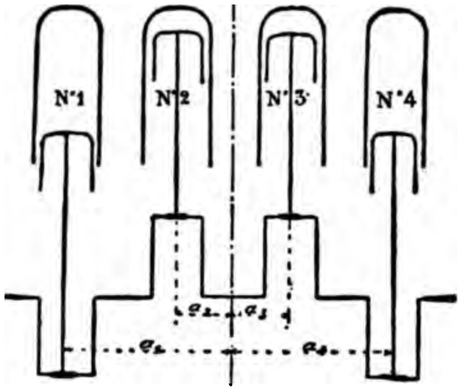


FIG. 15.—TYPICAL BALANCE OF STROKE OF A FOUR-CYLINDER MOTOR.

Pistons are at the beginning of stroke. No. 1, exhaust; No. 2, firing; No. 3, suction; No. 4, compression.

strokes of the four-part cycle. If the cranks are set at angles of 90°, however, the strokes of the cylinders would be contemporaneous only by pairs, and the fly-wheel would receive a power-impulse at every quarter of a revolution. The piston strokes are not usually made non-contemporaneous in motors with an even number of cylinders. It is apparent that, in addition to greater power, a multi-

ple-cylinder motor secures better balance in its operation, thus overcoming the main objection to the single-cylinder motor, namely, its tendency to set up vibration annoying to the passengers and destructive to the framework of the car. The earliest attempt at balancing-motor operation is seen in the V-shaped Daimler motor used in the early days of modern construction. In this, two upright cylinders were set at an angle of 30° to each other, both pistons working on one crank, the power-stroke of one corresponding to the suction-stroke of the other. This is the arrangement most typical in present-day construction of two-cylinder motors, except, of course, that the cylinders are no longer inclined to each other. Four-cylinder motors are in this respect really a pair of two-cylinder motors, two of the pistons being always at out-stroke while the other two are at in-stroke. Another two-cylinder motor is the horizontal double-opposed type, which has been most successfully developed on American vehicles. The cylinders are set at opposite ends of the common crank chamber, working on cranks set at 180°. (See Fig. 16.) This has the same effect as two upright cylinders working on the same crank, the out-strokes and in-strokes being contemporaneous and the firing-stroke in one cylinder corresponding to the suction-stroke in the other. Three-cylinder motors are employed upon the Brooke, Duryea, and one of the Panhard cars, the cranks being set at 120°, and the strokes of the pistons not being contemporaneous, but giving a power-

impulse at every two-thirds of a fly-wheel revolution. American motor construction adhered at first to the single-cylinder, depending for balance upon the fly-wheel and other devices, but the present tendency is toward the use of two- or four-cylinder motors on all but the lighter forms of car. Cylinders may be placed vertically or horizontally, and some modern types approach the inclined position of the early Daimler motor. The advantage of

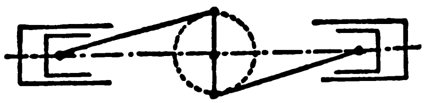


FIG. 16.—BALANCE OF HORIZONTAL, DOUBLE-OPPOSED TWO-CYLINDER MOTOR.

horizontal cylinders is that their vibration agrees with the motion of the car, but they tend to become oval, thus in time requiring reboring. In by far the majority of motors the vertical position is adhered to.

The operation of the valves for the admission of the explosive mixture is most commonly secured automatically by the suction of the piston during its inhaust or charging stroke, the valve returning to its seat at the end of the stroke by the pressure of a spiral spring. The exhaust-valves for the escape of the burned gases are operated by levers moved by cams upon a shaft so geared to the crank-shaft that it revolves once in every two revolutions of the crank-shaft, hence it is called the two-to-one shaft. (See Fig. 14.) Many modern motors

have the inlet valves, also mechanically operated by shaft-cams or eccentrics, and this method seems to be growing in favor.

From what has been said, it is apparent that every gasoline vehicle-motor must be provided with a suitable supply of explosive mixture and with some means of firing the same in the combustion chamber of the cylinder at the proper intervals. This mixture consists of a spirit vapor combined with ordinary air. All oils and spirits at certain definite temperatures give off inflammable vapors which may be readily ignited. Gasoline, or "petrol spirit," is the most familiar of these hydrocarbons, and the one employed in nearly all automobile-motors. The vapor given off by this liquid on contact with the air is a well-known source of danger in handling it near a flame. When shut off from the air, as in a motor-cylinder, this vapor can not be ignited without the admission of sufficient oxygen for the process of combustion. Advantage is taken of this fact in the Hornsby-Akroyd motor and in the Diesel motor, in each of which the inflammable vapor is admitted directly to the superheated cylinder chamber, and fired by the subsequent admission of a sufficient quantity of air. The almost universal practise, however, is to mix the vapor and the air in a device called a carbureter, and to feed the carbureted air to the combustion chamber for subsequent explosion.

Roughly speaking, the carbureter is a vessel into which a small amount of liquid gasoline is

admitted, as required, through suitable outlet valves from the supply-tank. In the surface variety of carbureter (see Fig. 17) the air is admitted to the surface of the spirit in a current which licks up the vapor by evaporation, and is de-

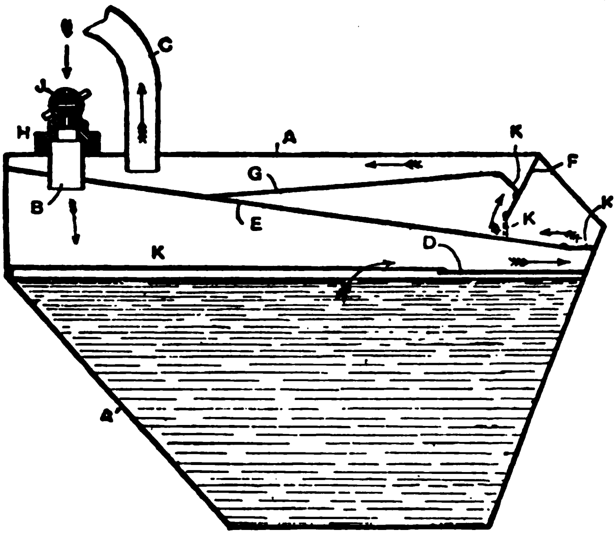


FIG. 17.—TYPE OF SURFACE CARBURETER (FAURE) WITH ZIGZAG BAFFLE-PLATES,

D E F G, to prevent liquid reaching the motor supply-pipe *C*; the tank, *A*, is filled by pipe, *B*, which also admits pure air; gratings at *K* permit the passage of the mixture in the direction of the arrows.

flected up the sides of the vessel by a plate which also prevents the liquid from splashing from the motion of the vehicle. The spray or atomizing carbureter, however, is the one most commonly employed. (See Fig. 18.) In this the current of air is

drawn by the suction of the piston stroke, causing a spray of gasoline to rise through a nozzle and play on to a cone, breaking it up immediately into vapor

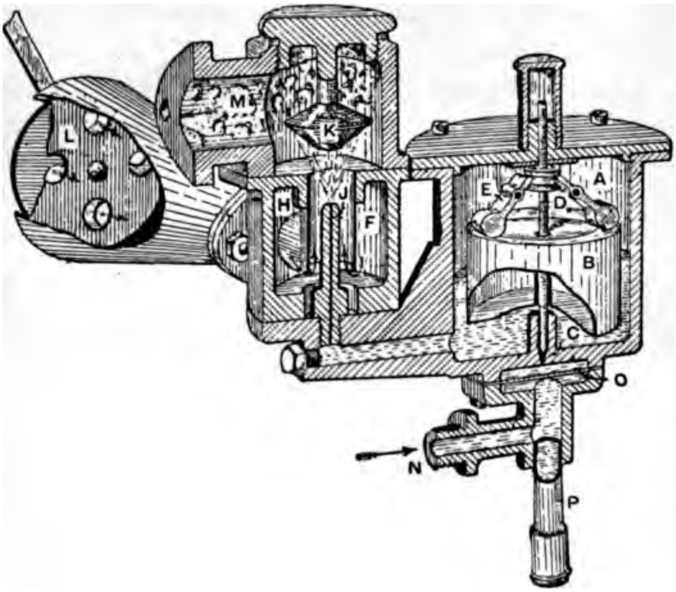


FIG. 18.—TYPE OF FLOAT-FEED SPRAY CARBURETER (DAIMLER-PHENIX).

Gasoline enters through *N* and wire gauze *O* (which keeps back solid particles) to chamber *A*; when it reaches the level of nozzle *J*, overflowing into chamber *H*, float *B* lifts the weight *E*, and rod *D* descends, pressing needle into valve *C*; suction of piston draws air in at *F* and liquid at *J*, which break and mix against *K*, and pass through *M* to motor; *L* is a variable lantern to control quantity of air.

and mixing it with the air. The level of the liquid is constantly maintained the same by means of a float controlling a needle-valve to the supply-tank.

This device is also employed on some surface carbureters, with a view to keeping the composition of the gasoline as nearly as possible the same, as the liquid tends to liberate its more volatile parts first, and gradually becomes impoverished if not continuously renewed.

To maintain the proportions of air and spirit vapor at a constant and, within certain limits, controllable ratio, is the crucial problem of carbureter construction. Wicks and other means are employed to this end in some varieties of surface carbureter. The spray carbureter, however, is capable of more uniform results and less liable to be affected by the jolting of the vehicle. Consequently, most automobiles are fitted with float-feed atomizing carbureters.

Temperature has an important influence on the working of the carbureter. If gasoline is cold it does not volatilize sufficiently; if too hot it does so to excess. This difficulty, most pronounced in cold weather, is provided against by circulating around the liquid in the carbureter the hot exhaust-gases from the cylinder or the water which has cooled it. In either case the quantity can be varied at will.

In early motor construction the ignition of the carbureted mixture was accomplished by a platinum tube pierced through the wall of the combustion chamber, and kept at white heat by means of a Bunsen flame at its outer end. The compression-stroke of the piston forced the inflammable mix-

ture against the inner end of this tube, and so ignited it. Such a method is obviously somewhat uncertain in its action, due to the varying degrees of compression at different speeds of the motor. At slow speeds the compression may not be sufficient to force the mixture against the tube, which results in slow firing or in total failure to ignite. At high speed, premature firing may result; or the mixture may be forced against the outside flame, causing back-firing or more serious harm, since the presence of the flame is, in any case, a source of danger. Consequently, tube ignition has been practically abandoned in favor of electric ignition, which is surer in its operation, and can be more accurately timed to suit the needs of the motor. This method consists in the production of a very hot electric spark directly within the combustion chamber. The electric current is controlled by cams operated on the two-to-one shaft geared to the crank-shaft of the motor so as to time the spark, as it does the exhaust, once in every two revolutions of the fly-wheel. Such a system, of course, requires a separate source of electrical energy. This may be a battery of galvanic cells, or it may be a small dynamo or a magneto-generator, either of which must be operated by the motor. The current thus generated may be used to produce a low-tension spark in a primary circuit from either a "wiping" or a breaking contact, or it may produce a high-tension spark (known as a "jump-spark") in a secondary circuit containing an induction coil.

Sparks of both varieties are used successfully on automobiles, although the "jump-spark" appears to be the favorite.

The principle upon which a primary or low-tension spark is produced will be understood from Fig. 19. *B* is the battery, or source of electrical

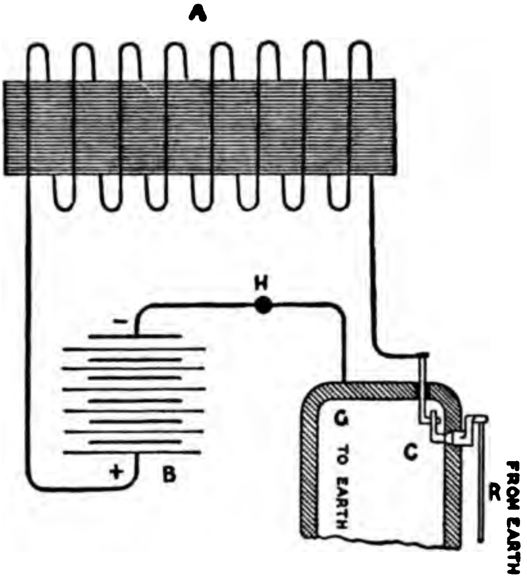


FIG. 19.—DIAGRAM OF A LOW-TENSION OR PRIMARY-IGNITION CIRCUIT FOR "WIPE" OR "BREAK-CONTACT" SPARKING.

energy; *C* represents the device for breaking the circuit within the combustion chamber. This may be accomplished by a rotating electrode, wiping against a stationary electrode or by having two electrodes normally in contact, one of which is slightly drawn away from the other at the moment of sparking. In either case this mechanism is

operated by a cam on the half-time shaft. While a small spark can be produced by simply breaking a primary circuit, this would not be sufficiently intense. Therefore to make it powerful enough to ignite the charge, a low-tension or self-induction coil, *A*, is introduced in the circuit. The circuit is grounded through the motor at *G* and returns through the frame of the car and the push-rod *R*. The induction-coil of this system consists, roughly, of an iron core wound with low-resistance copper wire. When the battery current flows through the winding it magnetizes the iron core, the effect of which is to generate an additional reverse current superposed on the battery current. When the circuit is broken within the combustion chamber, the magnetic reactance of the coil tends to continue the flow of the self-induced current as a direct current taking the place of the battery current, and at the moment of breaking it produces an adequate spark.

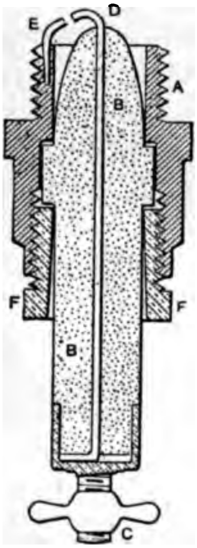


FIG. 20.—SECTION OF DE DION - BOUTON SPARKING-PLUG.

B, porcelain insulation screwed into cylinder wall, *A*, by screw-plug *F*; electrical connection is made at binding post *C*; the current passes back from the sparking-point, *D*, through *E* and the motor wall to earth.

There are two principal methods of producing

a high-tension or jump-spark between permanently separated electrodes, insulated in a sparking-plug (Fig. 20), which is set into the combustion chamber. The first method, of which the de Dion system is typical, is illustrated in Fig. 21. The familiar Ruhmkorff coil is here employed, the theory of which is, roughly, that if a primary or

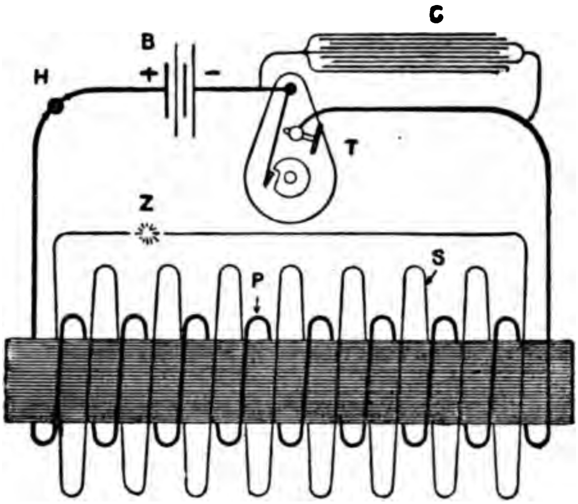


FIG. 21.—DIAGRAM OF HIGH-TENSION OR SECONDARY-IGNITION CIRCUIT WHERE MECHANICALLY OPERATED CONTACT-BREAKER (*T*) PRODUCES A JUMP-SPARK, AS IN THE DE DION SYSTEM.

low-tension current is passed through a coil of wire around a soft iron bar, both being insulated from each other, the bar becomes a powerful magnet. If this primary coil is wrapped with another coil of fine wire insulated from it, then whenever the primary current is interrupted a secondary current of high tension is immediately set up in the outer coil.

It is this current which produces the spark in the sparking-plug. In the figure, *B* represents the battery or source of the primary current, which is led through the switch, *H*, passing around the coil core, where it is indicated by *P*, thence to the contact-breaker at *T*, where it is grounded through the motor, returning through the frame of the car to the negative pole of the battery. The secondary circuit, *S*, with its sparking-point at *Z*, within the cylinder, is led around the core and its primary winding. When the primary circuit is made by means of the contact-breaker, *T*, an induced current in the opposite direction is set up in the secondary circuit *S*. This is not, however, strong enough to cause a spark at *Z*, because it is retarded by the inverse self-induced current of the primary winding of the coil, which tends to neutralize the rapid flow of the battery current. A condenser, *C*, is therefore connected in shunt across the terminals of the contact-breaker. When the primary circuit is broken at *T* the electrical pressure flows back from the condenser through the primary coil, instantly demagnetizing the core and enabling the secondary current to reach a potentiality high enough for it to leap the gap, *Z*, in the form of a spark.

The operation of the contact-breaker may be understood from Fig. 22, illustrating an early form of the de Dion variety. *H* is the insulating cover of the apparatus. The primary current from the positive pole of the battery runs through the screw,

A, the end of which is covered with platinum and rests against a platinum blob on the flat vibratory spring, *T,* known as the trembler. From the trembler the current runs through the screw, *B,* to the grounding wire, and thence back through the frame of the car to the negative pole of the battery.

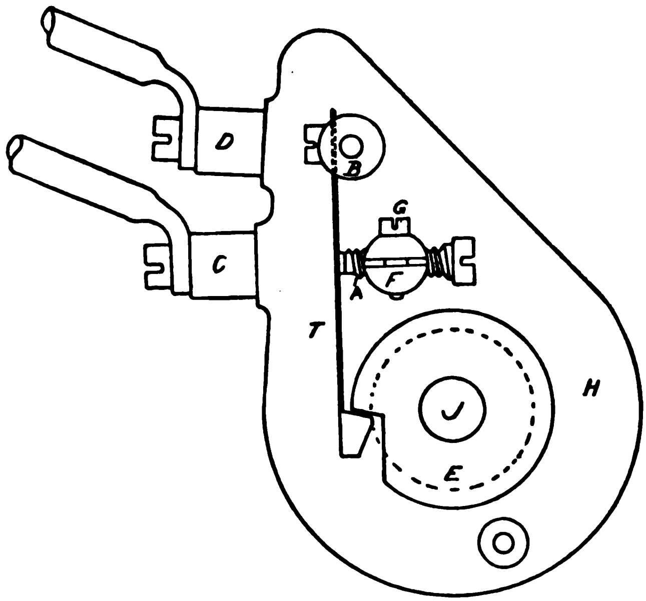


FIG. 22.—PLAN OF DE DION CONTACT-BREAKER FOR HIGH-TENSION IGNITION.

It will be seen that when the wedge of the trembler rests in the notch of the cam, *E,* the circuit is made. As the cam revolves, the trembler is pushed out of contact with the screw, *A,* and the circuit is broken. As the cam is set on the two-to-one shaft, it automatically makes and breaks the primary circuit

once in every two revolutions of the motor fly-wheel.

By means of a rod and lever attached to the steering-wheel, the driver may swivel the contact-breaker, within certain limits, around the cam so that the wedge on the trembler will engage with the notch a little earlier or later than when in its normal position. This enables him to advance or retard the firing of the charge. Transmission of the combustion in the explosive mixture is not so instantaneous as might be supposed. If the spark occurs when the piston is at the extreme height of its stroke and the crank-pin at the dead point, combustion, if the mixture is too rich, has not time to be complete, and the total expansive power is not obtained in the work of driving the piston on its downward stroke. It is better, therefore, for the spark to occur a little before the end of the compression-stroke. The sparking-cam is set so that with a minimum advance by the operator the charge is fired just before the end of the compression-stroke, and with a maximum advance, just after the commencement of the second half of the compression-stroke; though with a large spark, a hot cylinder, and well-mixed fuel the spark is seldom set more than 15° or 20° ahead of dead center as measured on the crank. In slow-speed motors it is generally set about 5° after dead center.

The system of jump-spark ignition described above is essentially that of de Dion and Bouton, and is of the "break-contact" variety. It is best

adapted to single-cylinder, high-speed motors. One objection to it is the large primary current required, which quickly exhausts the battery. The chief difference between this system and that employing wipe or brush contact is in the method of breaking the primary circuit. In the magnetic-trembler system, of which the Benz circuit is typical, the primary circuit is made automatically by a contact mechanism improperly called the "commutator."

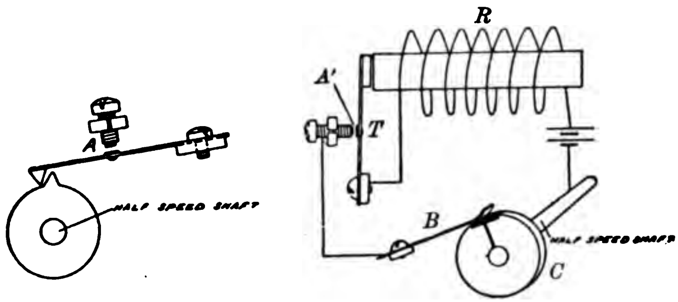


FIG. 23.—METHOD BY WHICH THE TREMBLER BREAKS THE PRIMARY CIRCUIT, DE DION SYSTEM, AT *A*. BENZ SYSTEM AT *A'*.

Its operation as compared with that of the contact-breaker will be understood by reference to Fig. 23. A vulcanite disk, *C,* is rotated by the two-to-one shaft. The circumference of the disk contains a brass plate which is in electrical contact with the shaft. A spring, or "brush," *B,* bears against the disk, and as it wipes across the brass plate the primary circuit is made. The current immediately acts at the coil, *R,* magnetizing the core, which attracts the trembler, *T,* instantly breaking the circuit, and of course inducing the high-tension cur-

rent in the secondary circuit, not shown in the figure. The commutator is shown more fully in Fig. 24. By reference to Fig. 25 this system of wipe-

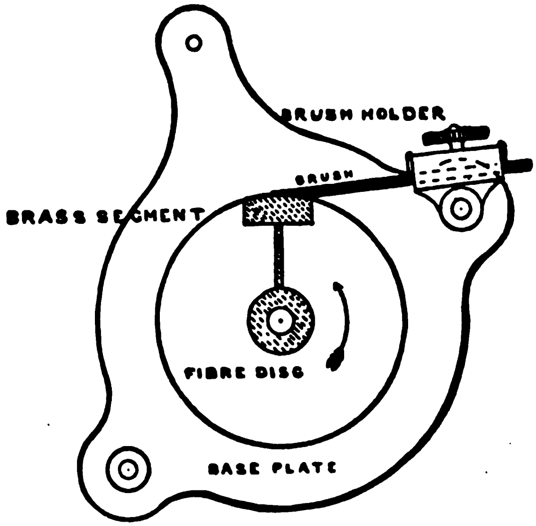


FIG. 24.—PLAN OF CONTACT MECHANISM OR "COMMUTATOR" OF THE BENZ SYSTEM OF HIGH-TENSION IGNITION.

contact jump-spark ignition may be more readily compared with the break-contact variety previously described.

With high-powered motors using the jump-spark ignition, storage-battery or "accumulator" is the usual source of current. This has the advantage that it can be recharged from any continuous electric-light circuit. The accumulator may be used alone as the sole source of current, or it may be used as a secondary battery to the primary dry-cell battery or to a small dynamo, in which case its

current is employed in starting, after which it is cut out of the circuit, and the dynamo furnishes the primary current for sparking.

In automobiles using a primary or low-tension sparking circuit, the current may be furnished by a small dynamo, but more often a magneto-generator is employed. In either case a storage-battery furnishes the necessary electrical energy for starting. A magneto-generator consists usually of three permanent, steel horseshoe magnets set on a metal base. On the inner faces of the magnets are fastened two hollow-faced pieces of metal called pole-pieces. (See *P*, Fig. 26.) Between these hangs the armature, a piece of soft iron hollowed out on both sides.

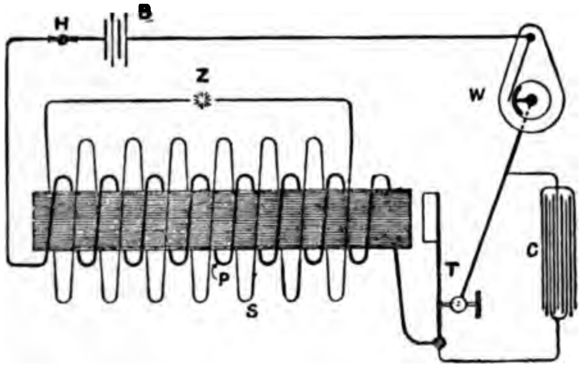
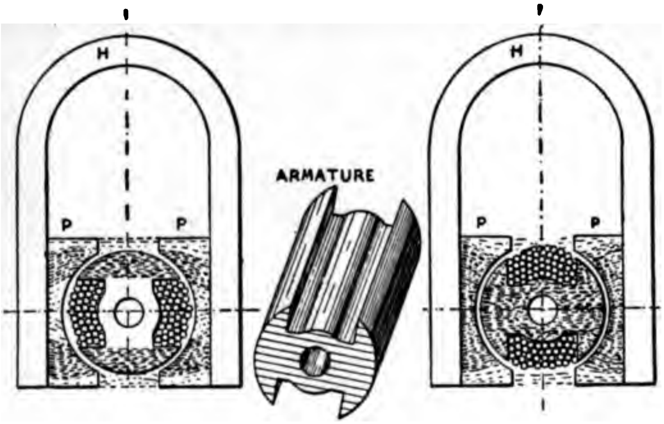


FIG. 25.—A HIGH-TENSION OR SECONDARY-IGNITION CIRCUIT WHERE WIPE- OR BRUSH-CONTACT "COMMUTATOR" AND MAGNETIC TREMBLER PRODUCE A JUMP-SPARK AS IN THE BENZ SYSTEM.

Around the armature, from end to end in these hollows, insulated wire is wrapped, forming a coil. Lines of magnetic force flow between the poles of the magnets through the soft iron of the armature,

when it is in the position shown at *A* in Fig. 26. If the armature be shifted to the position *B*, the lines will shift with it, following the direction of least resistance, since the armature winding of insulated wire acts as a non-conducting shield. Therefore if the armature be rotated or oscillated, an alternating current will be induced in the coil with which it is wound. By connecting one end of the armature winding with the frame of the car (grounding it) and the other with the sparking-plug, such a current may be employed for gas-engine ignition provided the cut-off of the current be timed exactly at



Position B. Position A.

FIG. 26.—PRINCIPLE OF THE MAGNETO-GENERATOR.
H, horseshoe magnets; *P*, pole-pieces.

the point of greatest intensity, which is when the armature is in position *A*. For ordinary ignition circuits an alternating current is not used, and the magneto, when employed with them, is provided

with means such as are used on the dynamo for producing a direct current.

The simplest form of low-tension magneto ignition is the Simms-Bosch system, which operates with the ordinary alternating current, making and breaking the circuit at precisely the instant of greatest intensity. In the Simms-Bosch magneto the armature is stationary (see Fig. 27), and between it and the pole-pieces of the magnets an open-sided hollow cylinder of soft iron is oscillated by means of a connecting-rod and crank geared to an adjustable cam on the two-to-one shaft of the motor. The same cam also operates to break the circuit at contact-points in the combustion chamber at precisely the instant when the oscillating sleeve cuts through the greatest number of magnetic lines. (See Fig. 28.) The winding of the armature, *A*, has one end grounded through the base-plate of the magneto, the current returning through the motor to the point *S*. The other end of the winding is led through an insulated post to the nut, *N*, by which it is connected with a stud brought through the cylinder wall, where a wiper, indicated by dotted outline. normally rests against it by

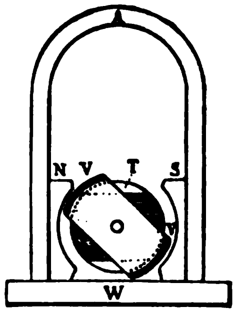


FIG. 27.—PRINCIPLE OF THE SIMMS-BOSCH MAGNETO FOR LOW-TENSION IGNITION.

A, magnet; *W*, base-plate; *N S*, pole-pieces; *T*, stationary armature, with winding; *V V*, oscillating sleeve of soft iron.

means of a spring. The cam, *C*, on the half-time shaft, makes this contact just before sparking, and immediately breaks it again by permitting the ham-

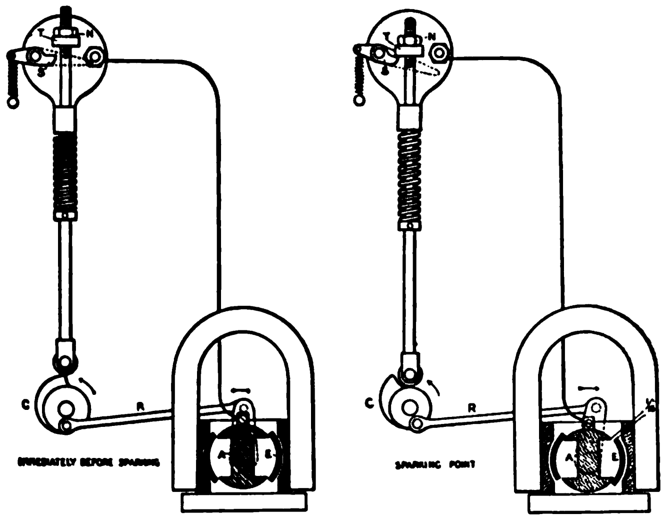


FIG. 28.—SIMMS-BOSCH LOW-TENSION MAGNETO SYSTEM OF IGNITION.

mer, *T*, to fall on the cam *S*. At the same instant the shield, *E*, is oscillated by the connecting-rod, *R*, so as to give the magnetic lines the direction of greatest intensity. As the contact is broken at *N* the spark is produced.

It is apparent that the rapid and continuous explosion of the inflammable mixture in the combustion chamber would soon heat the cylinder to a point where the piston would bind against its walls and the lubricating-oil become oxidized upon the valves, quickly stopping the operation of the motor.

Means must therefore be provided for cooling the cylinder, which usually consists of a circulation of water around the cylinder in a jacket provided for the purpose. The simplest method of securing this is by the thermo-siphon system, illustrated in Fig. 29. It is, of course, desirable to use the same water over and over again as long as possible. Usually it is brought back to the proper temperature by being passed through a radiator (Fig. 30), and is then returned to the cylinder.

The question of proper temperature is a somewhat delicate one, inasmuch as the efficiency of a gas-engine is represented by the ratio of heat-units converted into work compared to the total heat

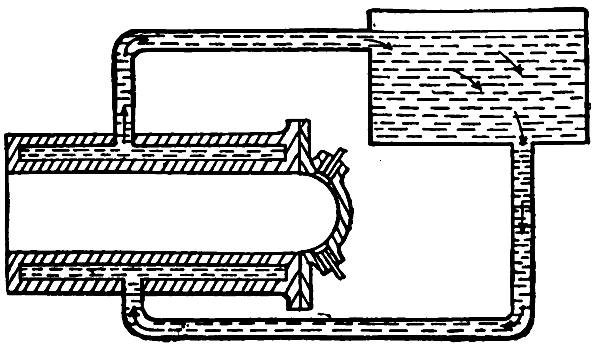


FIG. 29.—PLAN OF THERMO-SIPHON SYSTEM OF JACKET-WATER CIRCULATION FOR CYLINDER COOLING.

generated by combustion. Therefore it is equally important not to rob the cylinder of too much heat. If cold water were circulated around the cylinder, the action of the motor would be very quickly

stopped. The object of so-called cylinder cooling is really to keep the temperature of the cylinder walls somewhat below a point at which the efficiency of the motor would be interfered with, and at the same time to permit the temperature within the cylinder to be as high as possible. Most authorities agree that it is best to supply the water to the jacket at a few degrees below boiling-point. The water would then leave the jacket at a tem-

FIG. 30.—PORTION OF "LOYAL" RADIATOR.

perature slightly above boiling, and would be circulated through the radiator at a rate of speed just sufficient to restore it to the jacket at the same temperature at which it first entered. One author-

ity recommends the water should be used at the boiling-point and circulated by gravity as best insuring a fixed temperature for the cylinders. The

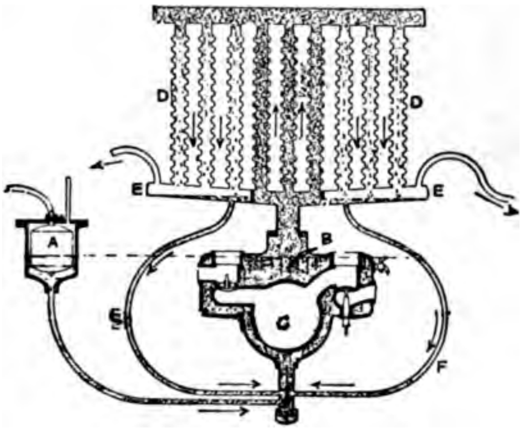


Fig. 31.

The float, *A*, fed from a tank, maintains a constant water-level in the jacket, *B*, of the cylinder *C*; the steam passes up the three middle tubes of the radiator *D*; condensing in the top tube it is led back by tube, *F*, from the bottom of tube *E*.

Gillet-Forest system consists practically in keeping a jacket of boiling water around the cylinder, which is replenished by means of a float-feed exactly in proportion to the rate at which vaporization takes place. The radiator is used merely to condense the vaporized water and return it to the jacket by gravity. (See Fig. 31.)

The multitubular or "honeycomb" radiator (see Fig. 32), once practically universal, has fallen somewhat into disfavor. Its chief recommendation was that it reduced evaporation of the water to

a minimum, but this very fact militates against the efficiency of the motor by keeping the jacket-water too cool. Various means are resorted to for securing the correct rate of circulation of the jacket-water supply, the most common being a pump, generally driven directly by the motor. While this method insures better control of the circulation than could always be assured with a gravity or thermo-siphon system, it is nevertheless apparent that the pump will vary with the speed of the motor. Thus at slow speeds the cir-

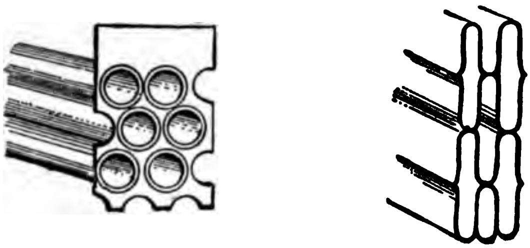


FIG. 32.—TYPICAL TUBES USED IN HONEYCOMB RADIATORS.

culation will be slow, even though the motor may be heating itself rapidly, as in hill-climbing; at high speeds the circulation will be rapid, although a high wind pressure may be added to its decreased cooling effect. In order to prevent freezing of the jacket-water when the motor is standing, solutions, usually of glycerin, or calcium chloride, are employed.

American builders have been most active in developing systems of air-cooling for automobile-motors. Such systems depend for their successful

operation upon various means of increasing the radiating surface of the cylinder, such as flanges or ribs, either cast solid with the cylinder wall or of different metal forced around it in grooves cut for the purpose. Rotary fans driven by the motor-shaft are generally used to induce a circulation of air around the cylinders. Fans are sometimes used in connection with the water-circulation system, in order to insure proper cooling of the radiator.

The disposition of the exhaust-gases from the cylinder constitutes another problem of motor construction. It is desirable to minimize the noise and prevent the dust which will be raised by direct escape into the atmosphere of these products of combustion. To accomplish this, the exhaust is led into a silencer or muffler, consisting in general of a chamber or series of chambers, of greater dimensions than the exhaust-pipe. (See Fig. 33.) In these the gases are gradually broken up and distributed to the atmosphere through finely perforated tubes.

The internal-combustion engine is not so elastic as the steam-engine or the electric-motor in adapting its operation to the work to be performed. When the gasoline-motor is overloaded, it stops. If it is high-powered enough to master unusual obstacles, it is inclined to race when the obstacles are not forthcoming. Some device must therefore be provided for regulating the speed of the motor itself. The two principal methods of governing are (1) by varying the force of the explosion, or

(2) by omitting a certain number of explosions in a given time. The first method is accomplished in various ways, as by varying the proportion of air or gas in the firing charge, or by reducing the amount of mixture admitted for firing. This is known as "throttling," and is the most common method. In throttling, either the supply-valve may be retarded from lifting, or an auxiliary cut-off valve may be operated in the supply-pipe either by

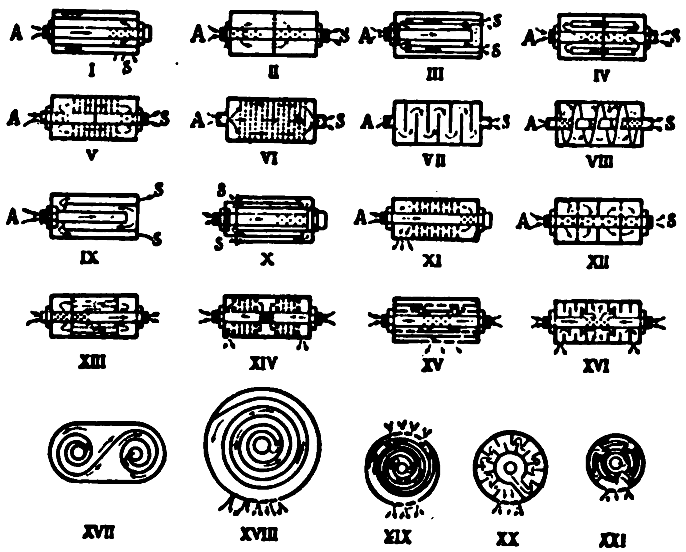


FIG. 33.—DIFFERENT ARRANGEMENTS OF MUFFLERS.
The exhaust enters at *A* and escapes at *S*.

the driver or by a centrifugal governor. Governing by cutting out the explosion altogether is preferable on the score of efficiency, which is seriously interfered with at times when the quality of the

mixture is changed and the compression-pressure reduced. The impulse may be suppressed by preventing the exhaust-valve from opening, retaining the burnt gases, which act as a buffer to the piston and prevent the admission of the charge on the suction-stroke. Or the exhaust may be left open on the suction-stroke, preventing sufficient vacuum to secure admission of the charge. This may be accomplished by hand or by a centrifugal governor on the principle illustrated in Fig. 34. Most governors for the suppression of the stroke, however, act directly on the inlet valve, or on the supply-pipe, to prevent admission. The speed of the motor may be varied by advancing or retarding electric ignition, but this is wasteful of fuel and only useful for temporary emergencies. The ignition-timing device is not intended for governing, but serves a different purpose. (See Chapter on How to Run an Automobile.) A governing mechanism may be geared to open the sparking circuit, but this is not usual, as it would be wasteful of fuel and, in the case of a battery current, would involve short-circuiting. Whatever the governing device, the

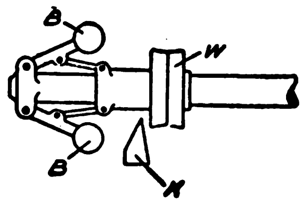


Fig. 34.—Centrifugal "Hit-and-Miss" Governor.

The knife edge, *K*, is geared to rise and fall with the exhaust-valve. If the fly-balls, *B B*, are rotated fast enough they will separate sufficiently to drag up the notch-wheel, *W*, till it prevents *K* from descending, thus holding the exhaust-valve open till the speed is reduced and allows *W* to fall again.

driver should be able to prevent its operation at will in order to secure the maximum of power from the motor when desirable.

As has been already explained, the gasoline-motor operates by the explosion of gas under pressure, thus producing expansive energy for the driving of the piston. The power of the engine depends, therefore, on conditions of volume, pressure, and temperature of the explosive mixture during the whole four-part cycle. Thus at the beginning of the inhaust-stroke, if we apply an indicator gauge to the cylinder, the pressure within is shown to be considerably below the pressure of the atmosphere (14.7 pounds per square inch), rising to about 13.5 pounds at the end of the stroke. During the compression-stroke the pressure rises from that of the atmosphere to 65 or 70 pounds, the volume of the gas reaching its smallest point at the end of the stroke, and the temperature rising to its highest point before combustion. Increase of temperature tends to increase of volume, and increase of volume to increase of pressure in the space within which the gas is confined. The charge being exploded just before the beginning of the power-stroke of the piston reaches its highest point of temperature, volume, and pressure. The temperature rises from between 500° and 700° to between 1,500° and 2,000°, and the pressure from 65 or 70 pounds to 200 or 230 pounds to the square inch, which is, of course, exerted on the piston, and if it could be so exerted until again equal to that

of the atmosphere it would be completely transformed into work. Now pressure decreases in direct proportion to the increase in volume of the gas; in other words, it is less at the end of the stroke than at the beginning. Obviously such a variation must be kept within very narrow limits if the efficiency of the engine is to be maintained practically constant. This explains why the ratio

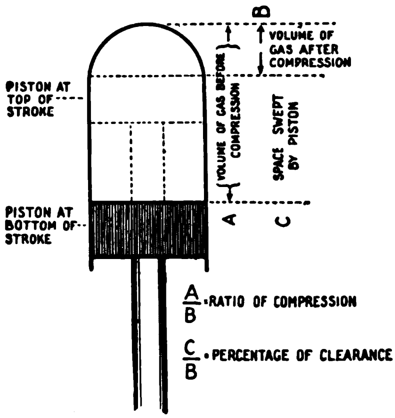


Fig. 35.—Diagram Illustrating Ratio of Compression and Percentage of Clearance of a Motor-Cylinder.

of the stroke of the piston to its diameter has such an important bearing on efficiency, since the longer the stroke the more uneven the pressure, due to greater increase in volume of the gas and larger surface for loss of heat-energy to the jacket-water of the cylinder. The ratio of compression is calculated by dividing the volume occupied by the compressed gas in the cylinder (*B,* Fig. 35) into the volume occupied by the gas before compres-

sion *A*. The percentage of clearance is found by dividing the volume of the combustion chamber, *B*, into the volume of that portion of the cylinder swept by the piston *C*. Both are important factors in determining efficiency; for a decrease in the size of the combustion chamber (reducing the percentage of clearance), if not so great as to reduce too much the explosive charge, will tend to increase the ratio of compression, giving higher temperature and greater efficiency. Thus, while in early gas-engines the compression-pressure never reached 50 pounds to the square inch, modern engines by nice calculations average a pressure of 70 pounds with correspondingly greater percentage of heat-units transformed into work, and smaller gas consumption per horse-power per hour. The average gas consumption per horse-power per hour is calculated by authorities at about 20 cubic feet, with engines of the most favorable construction. Increase in compression ratio obtained at the expense of a relatively long piston stroke tends to be neutralized by the relatively larger area of water circulation. The average loss of heat-units to the water-jacket is 52 per cent of the total fuel efficiency. No portion of the piston sweep may be left unjacketed, though a small economy may be maintained by employing a spherical clearance. A greater number of heat-units are sacrificed to the water-jacket when the engine is running at slow speed, since in high speeds the explosions follow each other so rapidly as to reduce

the percentage of heat-units absorbed. There is also greater economy in fuel consumption at high speed. Thus a 12-horse-power engine run at a speed of only 2 horse-power would consume one-third instead of one-sixth as much fuel per horse-power per hour as if run at full speed.

Another condition tending to decrease efficiency is presented by the necessity to exhaust the cylinder of the burnt gases, the heat-energy of which is not completely used up, since they are capable of further expansion. At the end of the power-stroke of the piston, the pressure of the burnt gases would be so far above that of the atmosphere as to retard the return-stroke of the piston were the exhaust-valve not opened at about seven-eighths of the power-stroke, when the gases begin their escape by their own expansion. The average loss of efficiency through the exhaust is about 16 per cent. Two interesting attempts have been made to overcome this loss from exhaust, by Messrs. Crossley and Atkinson in England. Two types of stationary gas-engines have been invented by them, one of which works on the Atkinson cycle, giving a power-stroke much longer than the compression-stroke, thus utilizing more nearly the full expansion of the charge. In the Crossley three-cylinder gas-engine the principle of double expansion or compounding is employed, as in steam-engines, by the escape of the exhaust into a third cylinder, where it expands at low pressure, converting its energy into work. It is probable that one or both of these

principles will eventually be applied in automobile construction.

The several conditions just outlined which tend to modify the efficiency of the gasoline-motor are not so formidable in practise as they at first appear. We are accustomed to think of efficiency as the relation between the heat (fuel) put into an engine and the work we get out of it, but in the present development of the automobile-motor the amount of fuel actually burned, while an important consideration, is not the most important, that being to get the maximum of power out of the minimum of plant. If it were possible for all the pressure of expansion developed at the temperature of explosion to act, down to atmosphere, on the piston without absorption of heat-units to any extraneous source, we should realize the "maximum theoretical efficiency" of the gas-engine. Since temperature and pressure vary in direct proportion, the rise in temperature from initial to explosion should represent this theoretical efficiency. In other words, if the temperature of compression (heat supplied to the engine) is 600° F., and the temperature of explosion (heat delivered by engine) is 3,000° F., then 2,400° F. are theoretically turned into work, the theoretical efficiency being $\frac{2,400}{3,000} = 80$ per cent.

But since the expansive gas is not allowed to exercise its pressure in work down to atmosphere, the temperature at exhaust would represent the

proportion of waste of the total temperature rise. If the exhaust temperature were 1,512° F., then $\frac{1,512}{2,800}$, or 63 per cent, would represent the heat wasted, leaving 27 per cent as the "actual heat-efficiency" realized under most favorable conditions. The highest possible percentage of available heat-units would be the ratio between the theoretical and the actual heat-efficiencies, which in the case above would give $\frac{27}{80} = 33\frac{1}{3}$ per cent as the "mean theoretical efficiency." "Mechanical efficiency" is estimated in terms of horse-power (H. P.). One horse-power is the rate of working when lifting 33,000 pounds—one foot in one minute—or it may be said to represent 33,000 "foot-pounds" per minute. A British thermal unit (B. T. U.) equals 778 foot-pounds per minute. This enables us to calculate the mechanical equivalent of a known quantity of heat, since it takes 42.42 B. T. U. to exert 1 H. P. for one minute, or, in other words, 1 H. P. per hour = 2,545 B. T. U. Since the calorific value of gasoline is 21,900 B. T. U. per pound, if we know the fuel consumption of a motor per hour we can approximate its theoretical efficiency in horse-power and *vice versa.*

To arrive at the mechanical efficiency of a given engine, it is necessary to calculate more closely. The formula $\frac{PASE}{33,000}$ = B. H. P. is employed for

this, where P = mean effective pressure per square inch on piston during power-stroke; A = area of

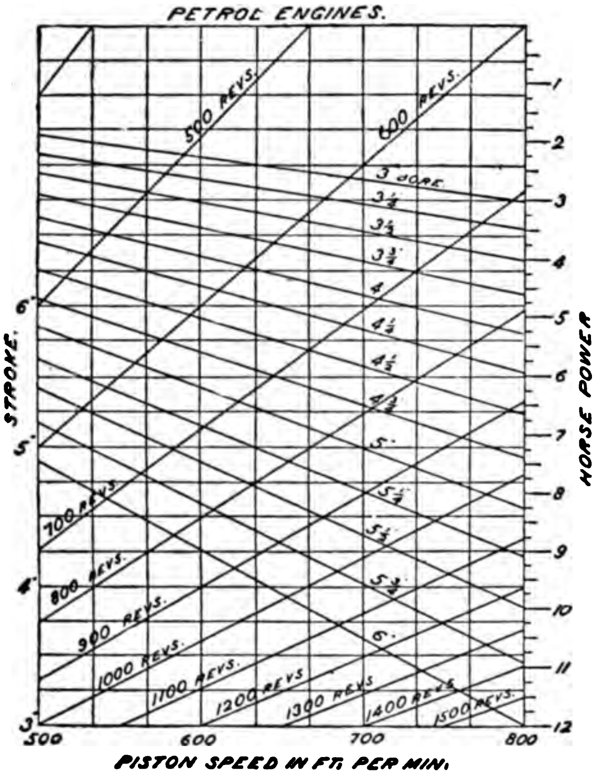


FIG. 36.—DIAGRAM TO DETERMINE B. H. P. OF A GASOLINE-MOTOR CYLINDER, KNOWING STROKE, BORE, AND R. P. M.

Find length of stroke at left, follow line to right till it cuts line of revolutions per minute; follow diagonal line till it cuts line of bore, then continue directly to right and read H. P. on vertical scale.

piston face in square inches; S = the length of the piston stroke in feet; E = the number of explo-

sions per minute. The product of these factors divided by 33,000, the number of foot-pounds per H. P. per minute, gives the "indicated horse-power" (I. H. P.) of the motor. This is the mechanical equivalent of the "maximum theoretical efficiency," and is, of course, greater than the actual or "delivered horse-power" (D. H. P.) under ordinary operative conditions. To calculate this it is usual to employ the formula $\frac{D^2LR}{18,000} = \text{D. H. P.}$ [Roberts], here $D^2 =$ square of piston diameter in inches; $L =$ length of piston stroke inches; $R =$ number of revolutions per minute. The denominator 18,000 is calculated by E. W. Roberts in his Gas-Engine Handbook for a four-cycle gasoline-engine.

The most satisfactory method of ascertaining the D. H. P. of a motor is by means of a Prony brake or with a dynamometer, and one or the other of these machines is employed by manufacturers in determining the stated "brake horse-power" (B. H. P.) of their motors.

Roberts's formula above may be modified for approximate calculations by assuming an average piston speed. Since general practise in four-cycle engines favors a piston speed of 500 feet per minute, in small stationary engines up to 700 feet, and in automobile-motors 800 to 1,000 feet, we may take 600 feet as a mean. Since there are two strokes of the piston to every revolution, $\frac{2L \times N}{12}$

$=$ the number of feet per minute traveled by the piston, and by assumption $\frac{2L \times N}{12} = 600$, hence $LN = 3{,}600$. Substituting this figure for LN in Roberts's formula, we get B. H. P. $= \frac{D^2 \times 3{,}600}{18{,}000} = \frac{D^2}{5}$. In other words, the horse-power per cylinder would be one-fifth of the square of the bore in inches; e. g., a motor with cylinders of 5 inches diameter, with assumed piston speed of 600 feet per minute, should develop 5 B. H. P. per cylinder per hour, or 20 B. H. P. for a four-cylinder motor. The denominator 5 may be reduced by 1 for every increase of 100 or 200 revolutions per minute. For more accurate calculations where bore and length of stroke are known, reference may be made to the convenient diagram from The Horseless Age, reproduced in Fig. 36.

CHAPTER III

THE STEAM-MOTOR

THE steam-engine, considered apart from its sources of expansive energy, was readily adaptable to automobile construction, since it was simple, reliable, and elastic in its operation, and could be made very light in construction. The two serious drawbacks to its use, which development has striven to overcome, are the bulk of its fuel- and water-supply. The chief effort in steam-motor construction has been to secure a boiler as small and light as possible, in which it would be possible to get up steam of considerable pressure in the shortest possible time, and which would not be unsafe in more or less inexperienced hands. It was equally important to provide a primary source of heat-energy less bulky than the ordinary fire-box and burning fuel more readily transportable, in sufficient quantities, than was possible with wood or coal.

The solution of the first of these problems rendered the tubular boiler imperative. Tubular boilers are of two kinds, fire-tube boilers and water-tube boilers, according to whether the tubes are to contain fire or water, respectively. Until recently,

fire-tube boilers were little used because of the difficulty of adapting the principle of the long horizontal tubes of the locomotive effectively to vertical use in the automobile. The small vertical fire-tube boiler has been chiefly developed in America. It is rarely over a foot either in diameter or height (see Fig. 37), but the large heating surface secured by the multiplicity of fire-flues makes it capable

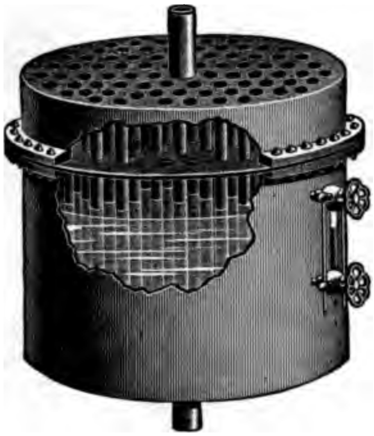


FIG. 37.—TONKIN BOILER, SHOWING PATENT BAFFLE-PLATE.

of generating a working-pressure of 150 to 180 pounds to the square inch, with a blow-off pressure of over 300 pounds. Several makes claim to have withstood tests of nearly three times their blow-off pressure. The tubes of such boilers are generally of copper, cold-drawn and expanded into the tube-plates at either end of the steel shell. Copper flues, as compared to steel, involve greater conductivity of heat and resist better the corrosion

and deposits of impure water, and are less liable to oxidization from heat. The inferior tensile strength of copper and copper-alloy tubing is not a serious drawback; in fact, it may work to positive advantage. Thus if the boiler should run dry, or become overheated accidentally, the worst that could happen would be the collapse of a few tubes, instead of an explosion through the outer shell. One of the gravest difficulties in such small boilers is the danger of priming (the escape of unvaporized water into the cylinder). This is overcome in some instances by the use of a metal sheet, called the baffle-plate, fixed above the water-level with a small clearance around it through which only dry steam can escape. In connection with this, a " separator " is sometimes employed, consisting of a pipe of large diameter, running across the top plate of the boiler, and connected to the motor by another pipe contained within it and having a number of small holes drilled in its length.

The preference given to water-tube boilers (see Figs. 38 and 39) in automobile construction indicates that, by their use, the control of circulation, by directing the rising and falling currents of water in the boiler, is most readily employed to secure quick steaming and greater durability. Chemical impurities precipitated from the water are more readily prevented from forming incrustations, being directed into mud-drums at the bottom of the water chamber, where they can be conveniently removed. The importance of this is

evidenced, in that a scale deposit of one-sixteenth of an inch in thickness causes a loss of 13 per cent of fuel energy. On the other hand, the water-tube

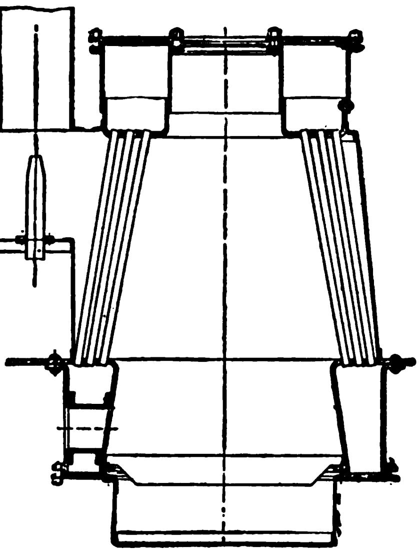


FIG. 38.—THE THORNEYCROFT BOILER (ENGLISH).

With water-tubes arranged circularly around the fire. Total heating surface 132 square feet; working pressure up to 225 pounds.

boilers tend to bulky and complicated construction, to greater liability to foaming and priming, and to danger of expulsion of water from tubes nearest the fire by overheating.

Another type of boiler had its origin in the famous "instantaneous generator" of Serpollet, invented in 1889. This consisted of a coil of steel tubing, with a bore of about one-eighth of an inch. This coil, surrounded by a cast-iron covering, to

protect the steel from oxidization by heat, was exposed to fire. When the coil was superheated, water was injected in regular impulses, each injection being almost instantaneously vaporized. The high velocity developed by the steam and water in the narrow bore was sufficient to keep the surface free from incrustations. For high-powered motors, two coils were used, one above the other.

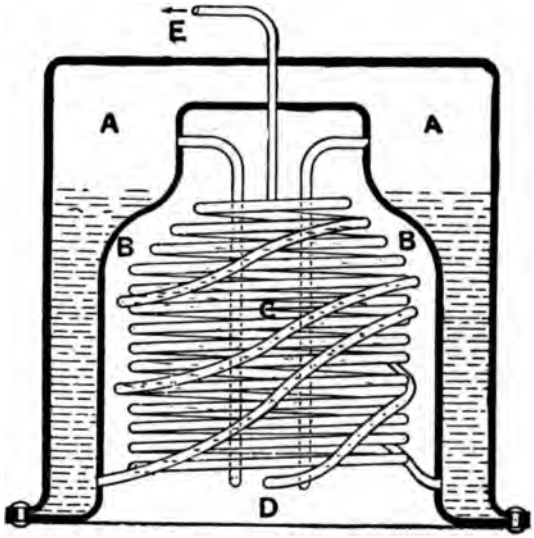
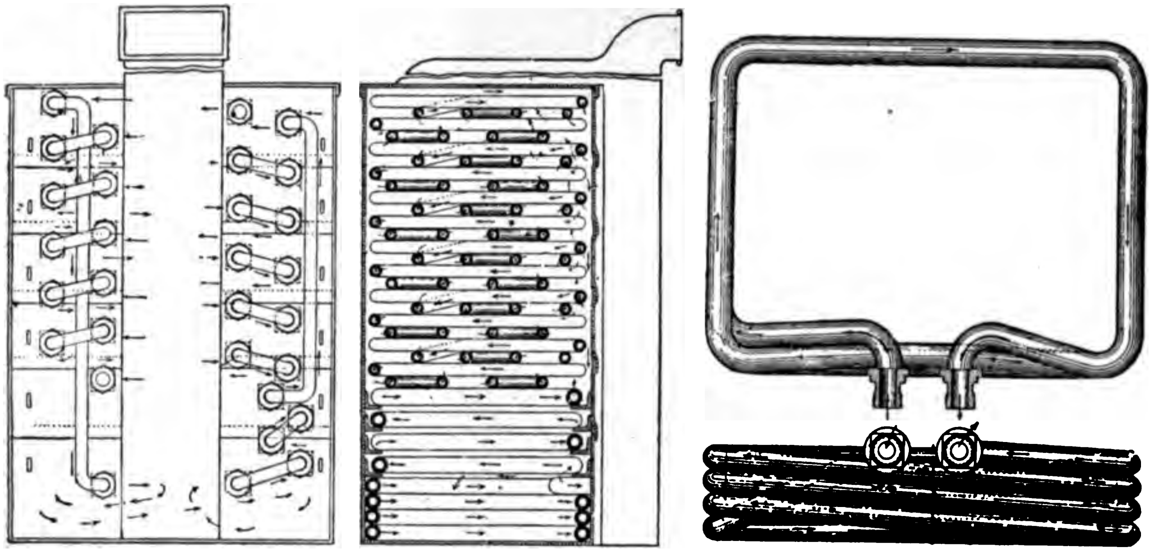


FIG. 39.—TOLEDO WATER-TUBE BOILER (AMERICAN).

Within the inner shell, *B B*, lengths of weldless steel tubing form a spiral coil *C*; burner-flame is at *D*; steam is taken from space *A A*, superheated in coil, and passed to motor through *E*. Working pressure, 200–250 pounds.

Water was injected into the lower coil and the steam was superheated in the upper. To stop such a motor, the feed-pump was simply shut off. A



I II III

FIG. 40.—THE GARDNER-SERPOLLET FLASH-GENERATOR (FRENCH).

I. Elevation showing asbestos-lined casing through which ends of tubular elements project and are connected as shown, all joints being made with copper-covered asbestos washers. II. Water enters at top, is given a preliminary heating in top element, then passes directly to the feed-water heater at bottom, thence upward through the elements; about half-way up, a long tube takes it directly to the element next the top; thence it passes down again, issuing as superheated steam about the middle. III. Feed-water heater, a square coil immediately above the burner.

pressure of 300 pounds to the square inch could be obtained for work, though the tube could withstand a test-pressure of 1,500 pounds.

Utilizing the principle of Serpollet's invention, several designers of automobiles have produced "improved boilers" along similar lines. Serpollet's first generator was simply a coil of flattened tubing; then two such coils were used, and lastly, a complicated series of coils and twisted tubing (see Fig. 40). In these the water was fed to the lowest tier, the steam being collected at the top. A directly opposite plan is followed in the most efficient flash-generators of other inventors (see Fig. 41), the water being introduced at the top and the steam superheated in the lowest coils. Thus the course of the water is always from a lower to a higher temperature, and absolutely dry steam is assured. With tubes of sufficient capacity, the flash-generator offers advantages in quick steam, high pressure, and immunity from scale, priming, and explosion, which are unsurpassed.

Liquid fuel, such as is used on all but the heaviest steam-vehicles, secures economy both in space, weight, and fuel energy, since combustion is complete. Weight for weight, petroleum is estimated to produce about twice the heat-efficiency of coal. Kerosene and gasoline are most commonly used, both being vaporized by the heat of the burner, on the principle of the Bunsen flame as applied to a gasoline-stove. Typical gasoline-burners for steam-carriage use are shown in Figs. 42 and 43.

The liquid gasoline is supplied from a tank, carried well away from the burner, and within this tank an air-pressure of 45 to 50 pounds to the

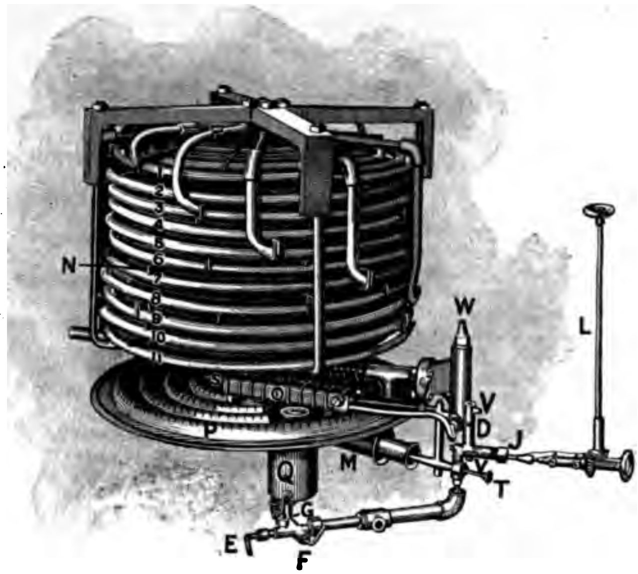
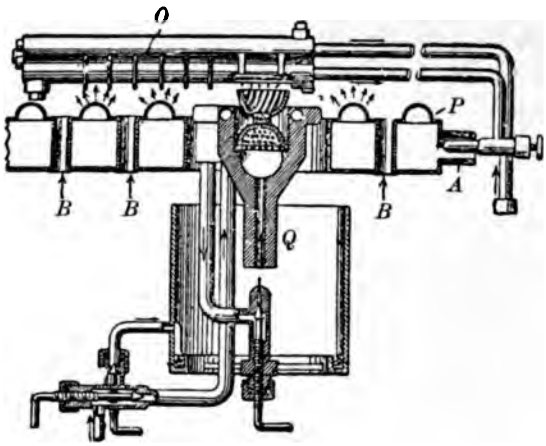
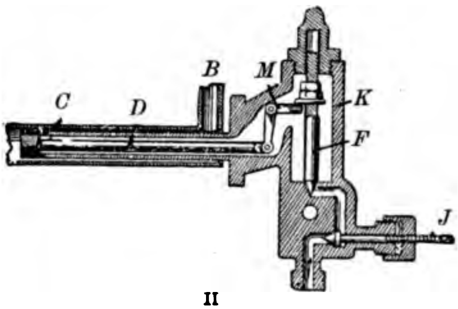


FIG. 41.—WHITE SEMIFLASH BOILER CONSISTING OF ELEVEN TUBES (1–11) OF SOLID-DRAWN STEEL TUBING WITH ONE-QUARTER OF AN INCH BORE.

Water enters coil No. 1 and passes to coil No. 2 through connecting pipe (shown on top), thence to coil No. 3 and so on, all connecting pipes being above the coils. The end of the bottom coil connects with a pipe which passes across the burner *P*. At one end this pipe contains a thermostat which regulates the flame of the burner in accordance with the steam pressure. The screw-cap of thermostat regulator is shown at *W* with clean-out caps *V V*. The superheated steam passes up again through the long vertical pipe whence it is fed to the motor. *J* is the main burner valve-stem; *L*, the connection to driver's seat; *D*, union with regulator; *T*, cleaning plug for nozzle; *M*, mixing tube; *E*, *F*, *G*, sub-burner gasoline valves; *Q*, subburner. The vaporizer is shown at *O* with its support *S*. The coils are held in position by spreaders, one of which is shown at *N*.



I



II

FIG. 42.—THE WHITE GASOLINE BURNER, REGULATOR, AND PILOT-LAMP.

P is a casting with its upper surface formed into ridges, with numerous slits across them. This and the metal pan on which it rests (Fig. 41) form an open space, into which vaporized gasoline and air are injected through the cone, *A*, then issuing from the slits. Auxiliary air passes from beneath through tubes *B*. The vaporizer, *O*, is heated by the burner when lit; in starting it is heated by a plate fixed to it immediately above the pilot-lamp *Q*. The thermostat, *C*, is carried by the casting, *K*, and consists of a brass tube, *C*, enclosing a steel rod, *D*, connected by a bell-crank, *E*, with needle *F*. When temperature passing around *C* reaches a certain point, expansion causes *D* to draw away from *K*, and consequently *F* reduces the feed of gasoline. The driver can regulate the flow of gasoline to burner by valve *J*.

square inch is maintained by a separate air-tank supplied by a pump. After the burner has been started the supply of gasoline is controlled automatically by the steam-pressure, which operates a

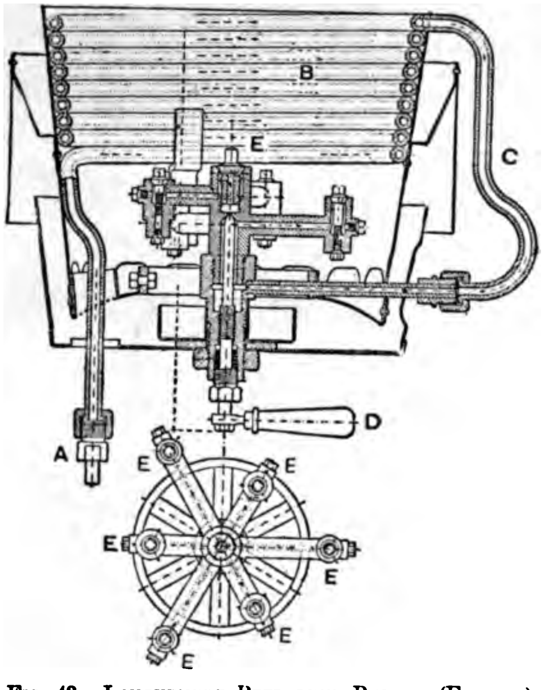


FIG. 43.—LONGUEMERE PETROLEUM-BURNER (ENGLISH).

Oil enters at *A*, is vaporized in steel worms, *B*, and is conducted by pipe, *C*, to screw-valve regulated by handle *D*. Seven burner-tips, *E*, are shown. The supply to each can be regulated independently, and any of them can be cut out at will.

needle-valve on the supply-tube. (See Fig. 42.) The air-pressure in the tank is increased, when necessary, to prevent the burner being blown out.

Types of burner-regulator are explained in Figs. 42 and 43.

The operative principles of the steam-motor itself are comparatively simple. The primary elements are the familiar closed cylinder, solid piston, and rigid piston-rod, the reciprocal motion of which is turned into rotary motion by means of the connecting-rod and crank. (See Fig. 44.)

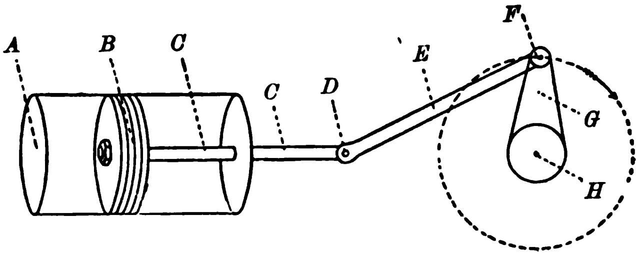


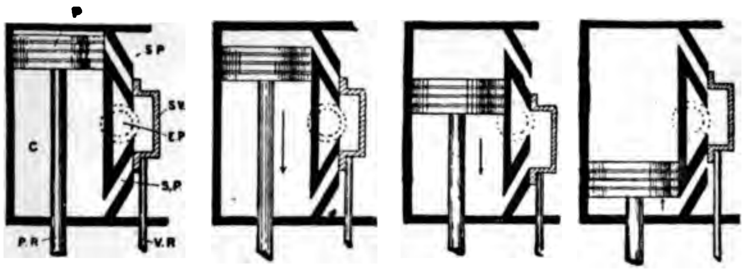
FIG. 44.—DIAGRAM OF RECIPROCAL AND ROTARY MOTION AS OBTAINED IN THE STEAM-MOTOR.

A, cylinder; *B*, piston; *C*, piston-rod; *D*, hinged joint; *E*, connecting-rod; *F*, crank-pin; *G*, crank; *H*, motor-shaft.

Steam is admitted alternately at either end of the cylinder, and its expansive force, bearing first on one face of the piston and then the other, drives it back and forth. Admission is accomplished by means of the sliding or D valve illustrated in Fig. 45.

The operation of the sliding-valve is insured by link motion, which will be understood from Fig. 46. Two circular disks, *F E* and *B E*, called eccentrics, are keyed to the engine-shaft so that the axis of the shaft passes through a point near their circumference. A ring encircles each eccentric, giv-

ing play so that the eccentric may revolve in the ring just as a crank-pin would. Rods *F* and *B* are attached to the rings and are joined at their opposite ends to a slotted metal arc called the link. In the slot is set the link-block, *B,* connected to the valve-rod. On this block the link can be slid in



I II III IV

FIG. 45.—PRINCIPLE OF THE SLIDING-VALVE OF THE STEAM-MOTOR.

I. Piston at top of stroke; valve closed. II. Valve opening, piston descending. III. Valve open; supply and exhaust taking place. IV. Valve opening for return stroke. *P*, piston; *C*, cylinder; *P R*, piston-rod; *S P*, steam-port; *E P*, exhaust-port; *S V*, sliding-valve; *V R*, valve-rod.

either direction by means of the reversing lever. As the engine-shaft revolves, the eccentrics, through their rods and the link, impart the desired motion to the sliding-valve, but in different ways, according to the position of the link. In position *I* (Fig. 46) the forward eccentric, *F E,* imparts motion to the valve, the other rod giving only a slight oscillation to the link. If the link be shoved over to position *III,* bringing the backward eccentric, *B E,* and its rod, *B,* into gear, motion will be imparted to the valve by it; but since the eccen-

trics are set at an angle of over 180° to each other, the motion will be in reverse order—i. e., the steam will be first admitted to the backward face of the piston. If the link be pushed over to its middle point, position *II,* no motion at all will be imparted to the valve, the eccentric-rods simply rocking the link slightly. Obviously between the points of "full gear" (*I* and *III*) and "mid-gear" (*II*) it is possible, by means of the link, to control the travel of the sliding-valve and to cut off the supply of steam to each side of the piston at different

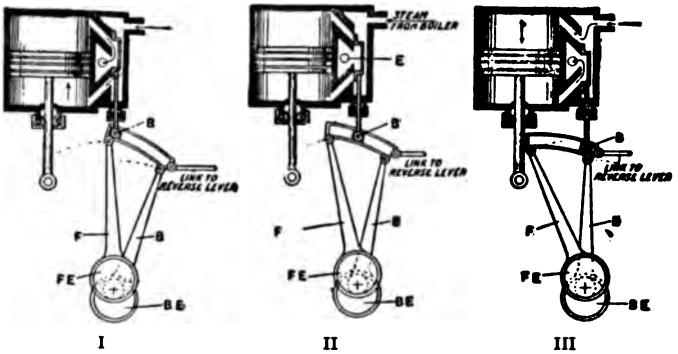


FIG. 46.—PRINCIPLE OF SLIDING GEAR AND LINK-MOTION OF THE STEAM-MOTOR.

I. Full gear forward. II. Mid-gear, no steam. III. Full gear reverse.

lengths of the stroke. If the link is geared to operate the cut-off at four-fifths of the stroke, obviously a higher pressure will be exerted on the piston than if the cut-off were made at one-third stroke, since in the latter case the steam is exerting its energy, for two-thirds of the stroke, below

boiler-pressure. But full boiler-pressure may not be required throughout the stroke for the motor to maintain its speed under given conditions. Furthermore, it works much more economically with a cut-off at one-third stroke than at four-fifths, in proportion to the fuel consumed. If the driver cuts off later than three-quarters stroke, he not only wastes steam, but he gets less power because of the back-pressure against the return-stroke, since the steam is not exhausted in time. With a cut-off at less than one-fourth stroke, the expansion of steam will cool the cylinder and cause the fresh charge to condense instead of to exert pressure. Between the limits of one-fourth and three-fourths stroke the driver must " notch up " his lever to give the earliest cut-off consistent with the work required of the motor. In small motors the limits of fuel economy by means of cut-off are much narrower, such motors generally requiring a fly-wheel to maintain balance which altering the steam-supply tends to disturb. A greater fuel economy than is possible with the cut-off is attained by compounding or using the exhaust-steam over again in one or more additional larger cylinders, where it is allowed to expand at low pressure. The cylinders may be placed end to end, using the same piston-rod when they form a tandem-compound engine. Or they may be placed side by side, operating on a common crank-shaft through separate pistons, forming a cross-compound engine.

CHAPTER IV

THE ELECTRIC MOTOR

THE electric motor considered by itself is vastly superior to any heat-engine in flexibility as to speed and power regulation, and in practical realization of theoretical efficiency. Electricity would therefore be the ideal motive agent for automobiles, were it not for the fact that each must carry its only supply of energy. This makes it impractical for the self-propelled road-vehicle to take advantage of the trolley system, which has proved to be the best method of electric traction yet devised. Primary batteries which directly transform chemical energy into electrical energy are not feasible as a portable supply of current, because, unless of too great weight and bulk, they do not furnish sufficient power, and because the chemicals they consume cost more than would the fuel necessary to produce an equal amount of energy by means of the dynamo. The electromobile is therefore dependent upon the secondary battery or accumulator as a self-contained means for the storage of electricity derived from some stationary generator.

The phenomena of electrical activity arise from the familiar tendency of electricity to distribute

itself evenly by passing from a point of high potential to one of lower potential, as evidenced in a flash of lightning. The tendency is analogous to that of water to seek the lowest level, or of heat being imparted by a warm body to a cold one, till the temperature of both is the same. Thus between a piece of zinc and a piece of copper or carbon in contact with the air there is a slight transmission of electrical energy from the latter to the former. Carbon and copper are much more susceptible to being charged with electrical energy than is zinc; they also give off such a charge more readily. Hence if we immerse two such dissimilar substances as a piece of copper and a piece of zinc in an electrolyte (in this case, a weak solution of sulphuric acid) and connect them through the air by a wire, the copper will tend to impart its electricity to the zinc along the wire, while through the liquid it will tend to receive electricity from the zinc. Thus a flow or current of electromotive force (E. M. F.) is established along the wire from the copper, or positive (+) *pole* of the battery to the zinc, or negative (—) *pole,* and through the liquid from the zinc as positive *plate* to the copper or negative *plate.* The current does not flow in the opposite direction because electricity seeks always the line of least resistance. Since the circuit-wire attached to the copper plate offers less resistance than the electrolytic solution, the copper plate, which is of higher "specific potential" than the zinc, readily discharges its electricity along the wire to the zinc.

The zinc, on the other hand, offers greater resistance to the passage of current than does the copper, and discharges its electricity more slowly. Hence within the liquid it has the higher potential. It must, however, discharge the E. M. F. heaped upon it from the copper plate along the wire, and it does this through the liquid, which offers less

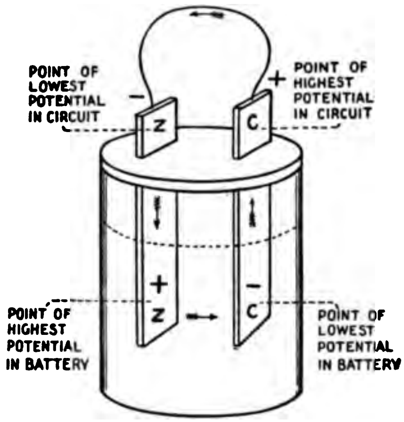


Fig. 47.—Diagram of Points of High and Low Potential in a Battery-Circuit and a Battery-Cell.

resistance than the wire already carrying a considerable charge of electricity from the copper. This will be better understood by reference to Fig. 47.

The passage of the E. M. F. through the electrolyte decomposes it, in the case of dilute sulphuric acid, into hydrogen, oxygen, and sulphuric oxid. The oxygen unites with the zinc, decomposing it, and the hydrogen is deposited on the copper in small bubbles. In order that the process

may continue till the zinc is exhausted, the cell is supplied with some "depolarizer" having a high chemical affinity for hydrogen. If we could reverse the process of the galvanic cell, by causing the current to flow in opposite directions, recombining the decomposed elements into their original form, we should have a fair analogy of the theory on which the accumulator or storage-battery is constructed. In 1801 Gautherot, by immersing two plates of platinum in an electrolyte and connecting one plate to each pole of a primary cell, discovered that the current operated to decompose the water in the secondary cell, bubbles of oxygen collecting on the plate connected with the positive pole and bubbles of hydrogen on that connected with the negative pole. He found, upon disconnecting the primary cell and connecting the platinum electrodes of the secondary cell, that the oxygen and hydrogen combined again, forming water, the action being accompanied by the flow of an electrical current along the wire between the two electrodes, in an opposite direction to the current from the primary cell. (See Fig. 48.) Gaston Planté in 1863 applied this principle in the construction of the first practical storage-battery. Instead of platinum, he suspended in dilute sulphuric acid two sheets of lead. When the current from a primary cell passed between them, the same electrolysis of the water took place, with the important difference that the oxygen, deposited on the anode, combined with the lead to form lead peroxide. Upon connecting the

positive and negative electrodes of the accumulator, a weak current could be obtained until all the oxygen combined with the anode had been liberated. Obviously this provided means for storing considerable E. M. F.

In order to answer the question, how much, we must understand something of the units of electrical measurements. A current of electricity is,

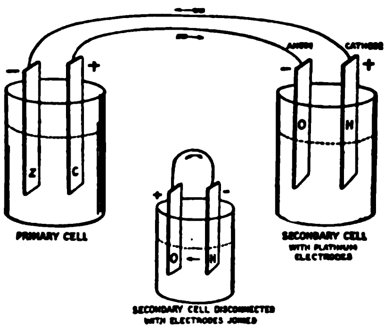


FIG. 48.—DIAGRAM ILLUSTRATING GAUTHEROT'S DISCOVERY OF THE PRINCIPLE OF THE STORAGE-BATTERY.

as we have seen, the passage of E. M. F., usually along a wire or other connecting circuit, from a point of high to one of low potential, or from the positive to the negative pole. The strength of this current is measured in amperes.

A current strong enough to deposit .00033 gram of copper, by the familiar electroplating process, during each second of the time it flows, is denominated a current of one *ampere*. If the current took ten seconds to deposit the same amount of copper, its strength would only be 0.1 ampere;

if it deposited twice as much copper in one second, or the same amount of copper in one-half second, it would be a current of two amperes, etc.

Since electricity always passes from a point of high potential to one of lower potential, we must be able to measure the pressure or intensity of the current at any point, and this is done in terms of the *volt*. One volt of E. M. F. represents the pressure sufficient to produce a current of one ampere on a circuit of one *ohm* resistance. We have seen that E. M. F. flows more readily through some substances than others. Thus the conductivity of a unit wire of silver is 100, copper 99, iron 16.8. An ohm represents the resistance to the passage of one volt E. M. F. by a column of mercury 106.3 centimeters high and one square millimeter cross-section.

The rate of mechanical energy of an electrical current is measured by the *watt,* which is represented by one ampere of current under pressure of one volt. Thus a current of eight amperes at 1,000 volts pressure has an energy of 8,000 watts or eight kilowatts (1 kwt. = 1,000 watts). Knowing the operative capacity of an electric motor in kilowatts, we can translate it into horse-power by dividing by 746, the number of watts in the English standard H. P. Knowing the voltage and amperage of an electrical current, we have but to multiply these together to obtain the number of kilowatts developed. The voltage of a current may be measured by an instrument known as the volt-

meter and its amperage by another instrument called the ammeter. For automobile use, the two are usually combined in one case, with the scale of each showing to the operator (see Fig. 49); who thus has before him a constant indication of the amount and intensity of his current, and of the rate at which it is being used.

The discharging capacity of the storage-battery is, unless otherwise stated, understood to be in

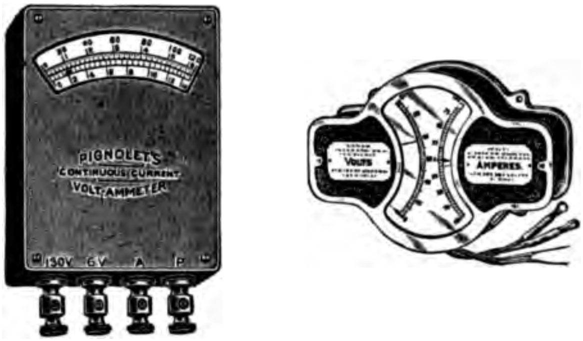


FIG. 49.—TYPES OF AMMETER FOR ELECTRIC VEHICLES.

terms of the strength of current it will deliver for eight hours without the cells falling below their specified voltage. Thus a battery rated at 80 ampere-hours, with cells of 1.5 voltage, will deliver a current of 10 amperes for eight hours without falling below the specified voltage. If we increase the rate of discharge, we decrease the ampere-hour capacity in proportion. Thus if we discharge a current at 20 amperes, the capacity falls to 60 ampere-hours; if discharged at 40 amperes, the capacity would fall to 40 ampere-hours. As a gen-

eral rule, the one-hour discharge-rate is about four times that of the eight-hour rate, which means that if the ammeter constantly shows a current of 40 amperes, the battery will not maintain its voltage for more than one hour. The three-hour discharge-rate is twice that of the eight-hour rate, and it or the four-hour rate are rarely exceeded for high speed. The strength of current used in charging an accumulator must be proportioned to its own ampere-hour capacity in accordance with instructions issued by the makers. Knowing the voltage and ampere-hour capacity of an accumulator, we can readily calculate its specific power output. An 80-ampere-hour battery, of 1.5 voltage, would have a power represented by 120 watt-hours, which means that it is capable of exerting a force of 15 watts per hour for eight hours.

Accumulators have been adapted in various ways to automobile use, the problem, of course, being to secure the greatest specific energy with the least bulk and weight, or, stated mechanically, the highest watt-hour capacity per kilogram. The efficiency of the accumulator is also an important consideration, being the amount of electrical energy it will discharge in proportion to the amount it takes to charge it. Average figures run between 70 per cent and 90 per cent.

In 1901 a new nickel-iron accumulator with 20 per cent solution of potash and water was announced by T. A. Edison. This gave 1.5 volts E. M. F., and was said to be capable of rapid

charging and discharging as well as overcharging without injury. It has not yet proved efficient in practical use.

Accumulators giving good results have been constructed by combining zinc and copper in an electrolytic solution of potash or caustic soda, giving an E. M. F. of about 0.8 volt. Lead and zinc, with dilute sulphuric acid, yield an E. M. F. of 2.4 volts, but are extremely difficult to charge. The

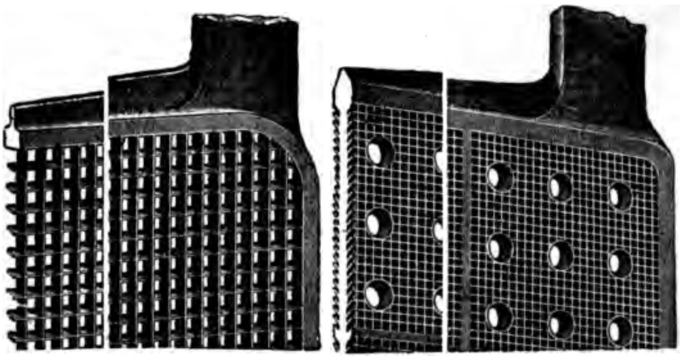


FIG. 50.—FAURE-SELLON-VOLCKMAR NEGATIVE AND POSITIVE PLATES.

most common form is the lead-and-lead, either of the Planté or Faure variety. The plates of the Planté kind are " formed " by a process of repeated charging and discharging of the cells till the plates assume a spongy character, which increases the surface exposed to the action of oxygen. Numerous modifications of this process have the same end in view. The Faure type consists of plates with numerous pockets or perforations, forming a " grid " in which active material is introduced in the form

of paste, composed usually of red-lead oxid and litharge. Sometimes a combination of these two types of plate is employed in the same accumulator.

Several varieties of accumulator plates and elements are shown in Figs. 50–55. Each element contains an odd number of plates, so that the positives may be enclosed by negatives, otherwise the positives would be acted upon unevenly and would warp. To prevent contact, thin perforated sheets of some non-conducting material are hung between the plates. The receptacles are generally of ebonite. Celluloid, on account of its lightness and transparency, would make an ideal container were it not so inflammable. The lid of the receptacle is usually sealed to prevent splashing of the liquid. The chief difficulty with "pasted" plates (which are the most prevalent type) is that the active material does not adhere to the grid satisfactorily. The chemical action, upon which the accumulator depends, tends to separate the paste from the support. Portions of it, falling between two plates or on the bottom of the cell, may effect connection between a positive and negative electrode, thus short-circuiting the battery and rendering it useless until fixed and recharged.

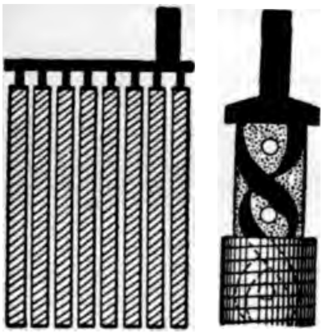


Fig. 51.—Pope Electrode.

The following table (from Hasluck's The Automobile) shows comparatively the specific constants of several varieties of accumulator, and will give a basis of comparison as to the energy to be derived in proportion to the weight (1 kilogram = 2.2 pounds):

Particulars of Accumulator.	Fulmen.	Faure-Sellon-Volckmar.	Pulvis.	Société Anonyme pour le Travail des Métaux.	Bouquet, Garcin, and Schivre	Phœbus.	Pisca
Number of plates in ordinary cell.....	13	23	7	13	15	13	13
Specific discharge in amperes per kg...	3	1.6	1.87	2.17	3	2	2.2
Specific useful power in watts per kg...	5.3	3	3.65	4.1	5.3	3.7	4.2
Specific capacity in ampere-hours per kg..............	14.6	8	9.37	7.76	21	9.9	6.6
Specific useful energy in watt-hours per kg...........	26	15	18.25	14.7	27.6	18.5	12.6
Specific weight in kg. per kilowatt-hour.	37.5	65	54.6	68	36.2	54	79.2

Calculations for weight based on this table will be higher than required in practise. The electric-carriage trials, held November, 1889, by the Automobile Club of France, demonstrated that accumulators giving 25 watt-hours per kilogram (2.2 pounds) can maintain a speed of 18 kilometers (11.2 miles) per hour for five hours, i. e., they can run the car 56 miles without recharging. The total weights of the accumulators varied from 26 per cent to 32 per cent of the total vehicle-weight when loaded. Hospatalier gives the following estimate of practicable relative weights:

Parts of Car, etc.	Weight in kg.	Weight in lb.	Weight in kg.	Weight in lb.
Accumulators...	—	—	300 to 350	660 to 770
Motor and transmission gear..	120 to 150	264 to 330		
Coupling, connections, accessories.....	50 to 80	110 to 176	680 to 850	1,496 to 1,870
Body, frame, and wheels........	300 to 400	660 to 880		
Two passengers and driver....	210 to 220	462 to 484		
			Totals, 980 to 1,200	2,156 to 2,640

Given a portable source of electrical current of sufficient intensity, there must be a means of converting the motive agent thus derived into rotary

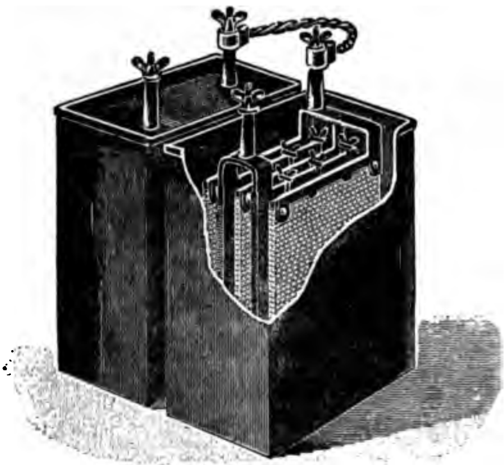


Fig. 52.—Lamina Accumulator.

motion. This is provided by the electric motor, whose general construction is the same as that of the dynamo, a machine for converting rotary motion into electrical current. The operation of the

motor, however, is exactly the reverse of the dynamo, and the latter may be run as a motor by simply changing its connections. Both depend upon the phenomena of electromagnetism and induced currents. A bar of iron wound with a coil of low-resistance copper wire becomes an electromagnet when a current of electricity is

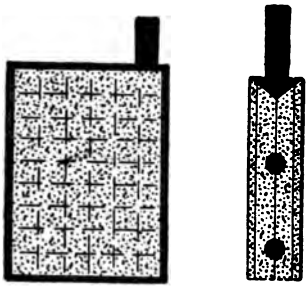


FIG. 53.—ROSENTHAL OR NATIONAL ACCUMULATOR PLATE.

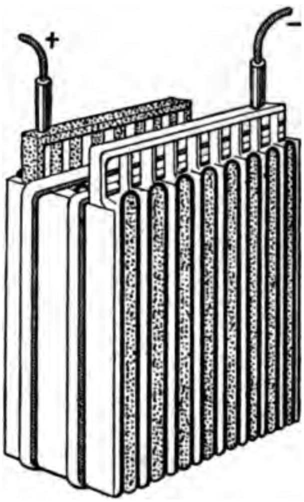


FIG. 54.—ROSENTHAL OR NATIONAL ACCUMULATOR CELL.

passing through the coil. Lines of magnetic force flow between the poles of the magnet. If these lines are cut by a double loop of wire (*C C,* Fig. 56) rotated on an armature *A,* a current will be induced in the wire which will reach its greatest intensity when the loop, *C C,* is in a horizontal plane relative to the lines of force. As the loop, *C C,* passes the horizontal, the direction of the current will be reversed. Two brushes, *B B,* may collect the alternating current from the insulated terminal drums of the circuit, *C C,* and the cur-

rent may be led from these brushes by a wire circuit *E*. This illustrates crudely the construction and operation of a dynamo. In practise the armature carries a great many loops,

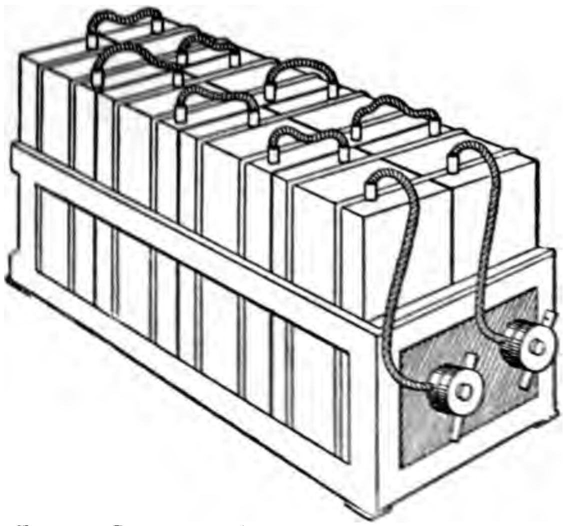


FIG. 55.—BATTERY OF ROSENTHAL OR NATIONAL CELLS.

thus cutting through the lines of force at great frequency and producing a current of higher intensity. Instead of the two drums shown in Fig. 56, the brushes take up the current from a commutator, a device which need not be described here further than to say it delivers the alternating current as a direct current.

The dynamo may have the terminals of the windings of its field-magnets connected to some extraneous source of electrical energy, in which case it is of the separately excited type. It is more

common to connect the terminals to the brushes, as there is sufficient magnetism in the field to induce a current at starting. The manner of connecting the field-winding is the important difference in dynamos so far as an understanding of the electric motor is concerned. These may be (1) series-wound, i. e., one terminal connected to one brush and the other terminal to the outside line; (2) shunt-wound, i. e., both terminals connected to the outside line, whose terminals are connected to the brushes; (3) compound-wound, i. e., a heavy low-resistance winding connected to the outside line as in series-winding, and an additional winding

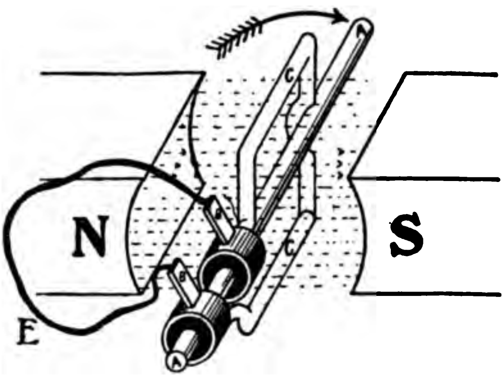


FIG. 56.—DIAGRAM ILLUSTRATING THE PRINCIPLE OF THE DYNAMO.

connected in shunt. Fig. 57 will make these connections clear.

As the dynamo-armature rotates, the reaction between its windings and the magnetic field polarizes the armature in a peculiar way illustrated in Fig. 58. *N N* and *S S* are the two points of con-

tact of the commutator-brushes where the current enters and leaves the armature windings. The

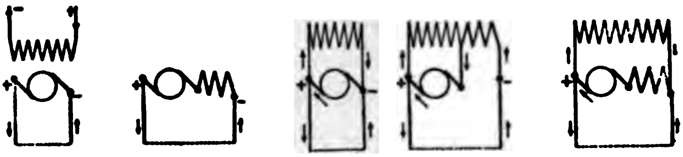


FIG. 57.—MANNER OF CONNECTING THE FIELD-WINDINGS IN DIFFERENT TYPES OF DYNAMO.

Field-windings are represented by zigzag lines and the armature by a circle with two tangents indicating the brushes as they rest on the commutator.

tendency of the current is to produce two magnets in the armature on either side of the "diameter of commutation," *D D,* with two north, *N N,* and two south, *S S,* poles, which are in effect one pole

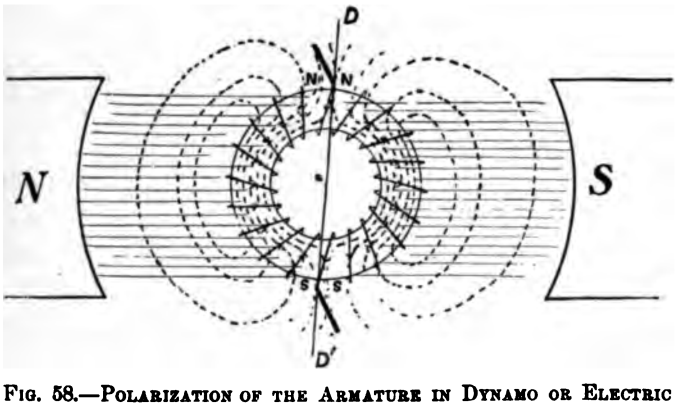


FIG. 58.—POLARIZATION OF THE ARMATURE IN DYNAMO OR ELECTRIC MOTOR.

at each point of brush-contact. The axis of the poles is at right angles to the lines of force between

the poles of the field-magnets, and there is a mutual attraction and repulsion between the armature poles and the field-magnet poles as the armature rotates. This acts as a magnetic drag on the rotation. In the case of the electric motor, where the current from the battery flows partly through the winding of the armature and partly through those of the field-magnets, polarizing both, the magnetic

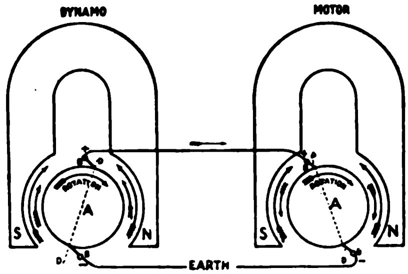


FIG. 59.—DIAGRAM OF THE OPERATIVE PRINCIPLES OF A DYNAMO AND MOTOR, THE FORMER SUPPLYING CURRENT TO THE LATTER.

N S, poles of the field; *D D*, diameter of commutation; *B B*, brushes; *A*, armature. Large arrows show direction of *E.M.F.*; small arrows, *C.E.M.F.*

drag becomes the driving force through which rotary motion of the armature is induced. This may be better illustrated in Fig. 59, which shows the operation of a dynamo driving a motor. The rotation of the two armatures, *A,* is in the same direction. The diameter of commutation, *D,* with the points of brush-contact, *B,* is inclined in the direction of rotation in the dynamo, while in the motor it is inclined against it. Large arrows indicate the direction of E. M. F. in the field, while

small arrows indicate the direction in the armature windings. In the dynamo the two directions are the same, i. e., from the lower to the upper brush. In the motor the E. M. F. of the armature is in the opposite direction to that of the field. The side-thrust from field to armature in the dynamo is therefore seen to be against the direction of rotation, while in the motor it is with it. It will be readily understood that this counter E. M. F. (C. E. M. F.) in the armature windings of the motor is increased as the strength of the field is increased for greater speed of the motor. The more rapid rotation of the armature tends in itself to increase the C. E. M. F., which operates to overcome resistance to the motion of the armature by virtue of the increased side-thrust from the field. Hence there is a greater resistance to the operation of the electric motor at low speed than at high speed.

Now this tendency of the rotating armature to overcome internal resistance more readily at high speed and under light load is the opposite of what it requires in practise, since the twisting-power or torque of the motor is the number of foot-pounds it can exert in overcoming external resistance or load. In series-wound motors the torque is almost directly proportioned to the E. M. F., and since a rapidly rotating armature generates more C. E. M. F., there is a corresponding loss of current strength and consequently of mechanical efficiency at high armature speed. If,

for example, the resistance of the armature winding is one ohm, and the E. M. F. of the battery current 18 volts, we would have an available current of 18 amperes. But if the armature is rotating rapidly enough to generate 12 volts C. E. M. F., the working strength of the current will be cut down to six amperes. A delicate problem therefore confronts the designer of electric vehicle-motors. Lightness must be combined with high power against relatively heavy load and even 100 per cent overload. In the light stationary motor designed for constant load, it is easy enough to secure power sufficiently high by high armature speed. In the vehicle-motor, power must be secured at low angular velocity of the armature. Hence in construction it is customary to have the armature of as large diameter as is consistent with the centrifugal pull on the winding, and to have the tangential speed of the transmission-gear as high as possible. The armature winding is also given as low resistance as possible, thus reducing the C. E. M. F., while the number of poles in the magnetic field is sometimes increased. Shunt-wound or compound-wound motors are occasionally employed in order to maintain constant speed under varying load by varying the strength of field.

The horse-power of an electric motor is calculated from the product of (1) its torque, T, which is found by brake test; (2) its speed, S, = armature revolutions per minute; (3) the radius, R, of the armature in inches multiplied by the

constant 2 π ($= 6.283$) and divided by the foot-pounds in 1 H. P. $\text{H. P.} = \frac{T \times R \times S \times 2\pi}{33{,}000}$.

The range of horse-power in small vehicle motors is very wide, most motors being wound to develop sufficient to take between 100 per cent to 200 per cent overload. One American concern states that some of their motors, which have been in continual use on express wagons for over a year, are worked frequently for five or six minutes to 500 per cent overload several times a day. Since the motor is capable of such elasticity, the speed of an electric vehicle is almost invariably varied by varying the speed of the motor. This can be accomplished by altering the voltage of motor terminals by introducing a rheostat in the armature circuit or by modifying the strength of the field or by coupling the armature windings in different ways. The most common and at the same time the best method consists in coupling the accumulator batteries in different combinations, so as to give currents of different intensities. In a 40-cell battery, for instance, arranged in groups of ten cells, each cell giving 2 volts E. M. F., the four groups may be coupled in parallel, giving a current of 20 volts. If the four groups be coupled in series, a current of 80 volts is obtained. By coupling each pair of groups in series, and then coupling the two pairs in parallel, a current of 40 volts may be obtained. These three couplings give three distinct speeds. Intermediate speeds can be obtained by

varying the number of cells in the groups or by introducing variable resistance in the circuit.

The strength of the field may be altered to modify speed by introducing a variable switch resistance between the field-circuit terminals; the lower the resistance, the more current it will take up from passing through the field-windings. The field-windings themselves may be connected in series or in parallel to vary the strength of field, and the armature windings may be coupled in the same way, thus giving a range of control over the E. M. F. of the field and the C. E. M. F. of the armature relative to each other. When two motors are used for driving, one on each wheel, which is now standard practise, these may be coupled, either in series or in parallel, thus giving double the power, or half the power at the same speed of the motors.

These various connections for the control of the electric vehicle are accomplished by means of the controller or speed regulator, the operation of which by the driver consists merely in moving a lever backward or forward. This lever moves a commutating switch consisting of a cylinder upon which are contacts, making various circuits by being rotated into connection with brushes rubbing against them. To the terminals of these brushes are connected the accumulator terminals, motor brushes, field, and armature windings, rheostats, etc. The ordinary type of controller is usually arranged to give four speeds ahead and two re-

verse. An "off position" cuts out the motor and connects the batteries in series for recharging. Common types of controller provide for change of speed by commutation of motor fields and of bat-

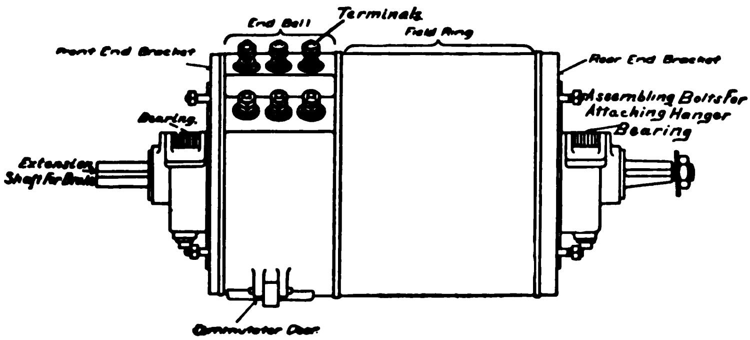


FIG. 60.—WESTINGHOUSE VEHICLE-MOTOR SHOWING CONNECTIONS.

teries in two groups, batteries generally being connected in series and fields in parallel on highest speed. Where more power than necessary for control of the vehicle is likely to be required, as in trucks, extra contacts are provided on the drum for introducing resistances into the field-windings.

Shunt-wound motors, which may be operated in the same direction as either dynamo or motor, may be arranged so that in running down-hill the motion of the vehicle wheels will drive them as a dynamo, furnishing current to the battery instead of receiving current from it. In series-wound motors, if the motor is run as a dynamo by the vehicle, and suitable resistance is interposed to transform the current into heat, the motor acts as a brake. The lower the resistance the greater the braking power.

Means must be provided to change the direction of the current in armature or field-windings, so that the motor will generate current by turning in the same direction, as when being run as a motor. The electric brake is not commonly used, because it complicates construction and, if applied at high speeds, is liable to burn out the armature windings. Views of typical vehicle motors are shown in Figs. 60 and 61, and a typical controller in Fig. 62.

Attempts, more or less successful, have been made to combine in one mechanism the advantages of the gasoline and the electric motor. In this system, the former takes the place of the storage battery and the latter that of the transmission gear.

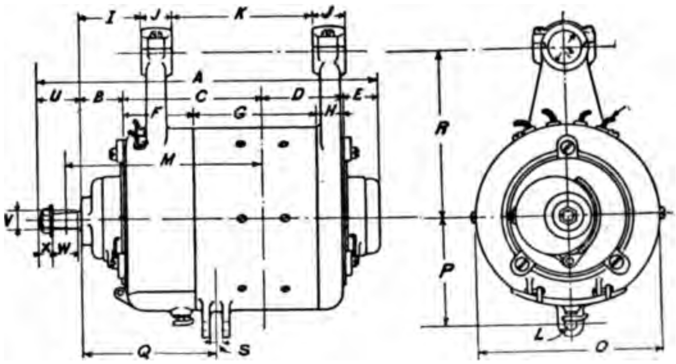


Fig. 61.—Side and Front Elevations of a General Electric Company's Vehicle-Motor.

The system consists in driving a dynamo directly by the gasoline-motor, the dynamo furnishing current to electric motors which propel the car in the usual way. The advantage of an independent, self-con-

tained source of electrical energy is evident, and obtained at greater efficiency weight for weight than with the storage battery. The control is, of course, much simpler than with either gasoline or steam as the motive power. There is decided increase in noise and vibration over the electric car with accumulator current, and also an increase in actual weight over the gasoline or electric vehicle. In starting the gasoline-motor, the dynamo is run as a motor by means of a battery current, so that the disadvantages of cranking, etc., are eliminated, as against the gasoline vehicle.

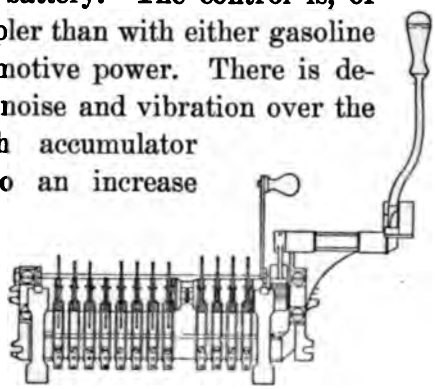


Fig. 62.—Pope Controller.

The most successful gasoline-electric systems appear to be those in which a small storage battery is added to the equipment. This absorbs the excess current not required in running, and renders it available when additional power is needed. The first practical gasoline-electric car appears to have been of American construction and was exhibited in Chicago by its inventor, W. H. Patton, about 1895. In May, 1896, H. J. Dowsing patented a much simpler system, which has been adopted by the Liège firm of Paris and shown in their Pieper car, exhibited at the Tuileries in 1899. In this car a storage battery is included as in the Fischer sys-

tem, which is typical of this construction. (See Fig. 63.) As yet the gasoline-electric system has not been developed to any extent for light vehicles. The Fischer system is apparently proving advantageous for commercial cars. The Lohner-Porsche

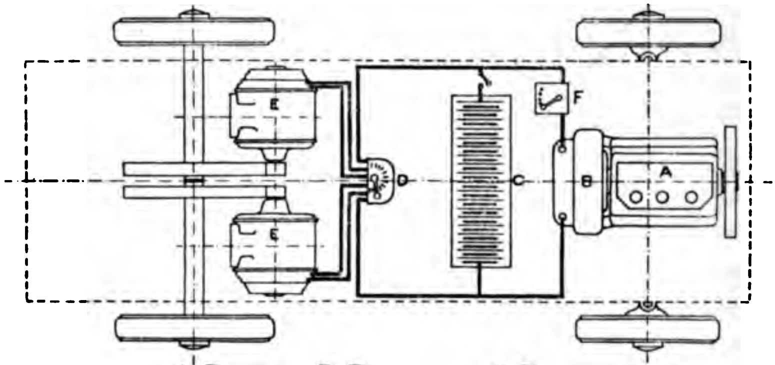


FIG. 63.—DIAGRAM OF FISCHER GASOLINE-ELECTRIC SYSTEM.

is a type of gasoline-electric without storage battery. In the Germain and the Hart systems no accumulators are used, but the dynamo-motor portion of the system really constitutes a sort of electric change-speed gear, the gasoline-motor driving direct and the dynamo-motors furnishing additional power or braking effect as required to control the speed.

CHAPTER V

TRANSMISSION AND CONTROL

Transmission of power from motor to road-tires involves in automobiles some nice problems of construction, which are most complex in gasoline-driven vehicles. Electric- and steam-motors possess considerable elasticity in speed-changing and reversal, permitting more direct transmission to the driving-axle. The gasoline-motor can change speed only slightly by modifying its power, which seriously interferes with its efficiency, and it is incapable of reversal. It would be exceedingly inconvenient to stop the motor every time it became necessary to bring the car to a sudden halt by applying the brakes, as the driver would have to dismount in order to start again. In coasting down hill the speed of the wheels would frequently exceed the speed of the motor, and if the two were directly connected, there would be great danger of injuring the latter by overrunning. Therefore, whatever the system of transmission employed in a gasoline-vehicle, it must be possible to disconnect it instantly and completely from the motor, allowing the latter to run independently when necessary. This is accomplished by means of a

clutch. In its simplest form this is merely a sliding ring or collar on the end of one shaft, on which it may be moved forward to engage positively with a slotted collar fixed at the end of another shaft. These "crab" or "jaw clutches" are not used for the main connection of the transmission-gear to the motor, as their action would be so sudden as to cause dangerous strain. The main clutch is most commonly of the "friction"

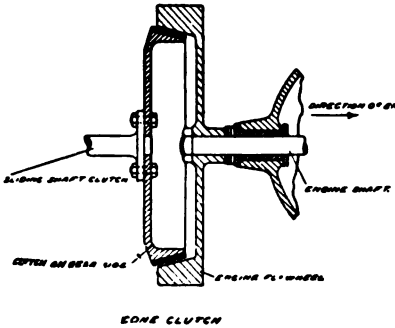


FIG. 64.—PRINCIPLE OF THE FRICTION-CLUTCH, CONE VARIETY.

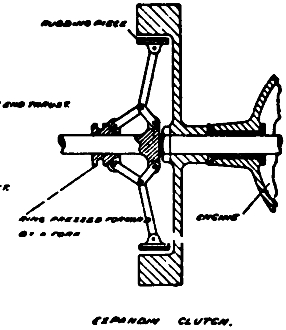


FIG. 65.—PRINCIPLE OF THE EXPANDING FRICTION-CLUTCH.

type. (See Fig. 64.) The friction-clutch is usually applied to the fly-wheel, one side of which contains a cone-shaped hollow wherein a solid or "male" cone at the end of the transmission-shaft is normally engaged by a powerful spring. A foot-pedal operated by the driver can instantly remove the pressure of the spring, and thus disconnect the secondary shaft. One or both of the conical surfaces of the clutch may be covered with leather or other substance conducive to frictional contact. A

variation of this type is the expanding-clutch illustrated in Fig. 65. Obviously the friction-clutch enables the secondary shaft to take up the power of the motor gradually, since the engagement is made with more or less slipping of the surfaces just as in ordinary belt-and-pulley transmission. Several variations of the above principle exist wherein the gradual engagement of parallel revolving surfaces is induced by spiral springs, by the hydraulic action of oil admitted by a valve, or by magnetic attraction. In the operation of the cone-clutch there is a decided tendency to undesirable thrust being exerted on one of the shafts at the moment of engagement. Various devices are employed for taking up this thrust by intermediary bearings. It is not present in clutches of the expanding type.

Reversal with the gasoline-motor may be provided for by arranging two clutches geared to drive in opposite directions, one being engaged for forward motion and the other when driving backward. Usually the reversing-gear is a part of the system of "change-speed gears" employed on all gasoline-vehicles and on many steam-carriages. All speed-changing mechanisms depend upon the familiar fact that when one cog-wheel or "pinion" drives, another motion is imparted to the second wheel in the opposite direction from the first, and at a speed varying directly with the diameters of the wheels. The most common way of utilizing this principle is by having a "second-motion shaft"

upon which pinions of different diameters are fixed so that they may be slid in and out of engagement with gear-wheels on the main shaft, which is driven by the motor through the medium of the clutch. Usually as many pinions or wheels are set on each shaft as there are speeds to be provided for. (See Fig. 66.) The second-motion shaft itself may be arranged to slide longitudinally, but generally the

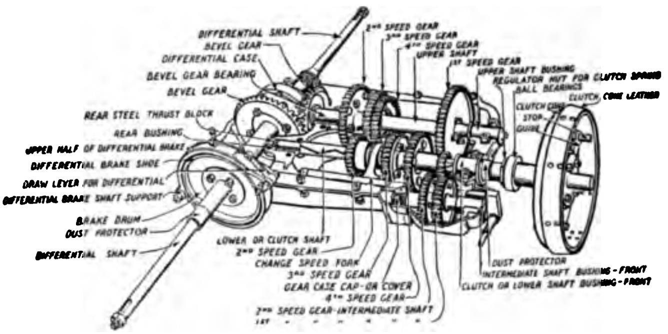


FIG. 66.—PANHARD CHANGE-SPEED GEAR.

toothed wheels are set on a sleeve which may be moved along the shaft, a portion of which is cut square to receive it. Sometimes the pinions are made to slide on the main shaft and the spur-wheels are fixed on the second-motion shaft. It will be seen that the successful operation of this system depends upon the facility with which the teeth of one set of wheels may be disengaged and another pair enmeshed by sliding one set of teeth exactly into the spaces of the other set. That this might prove difficult of accomplishment may well be imagined, and despite the various mechanisms designed to

make it easy, only practise can render the driver proficient in its operation. Reversal is accomplished, in this system, by introducing between a pinion on the main shaft and its corresponding

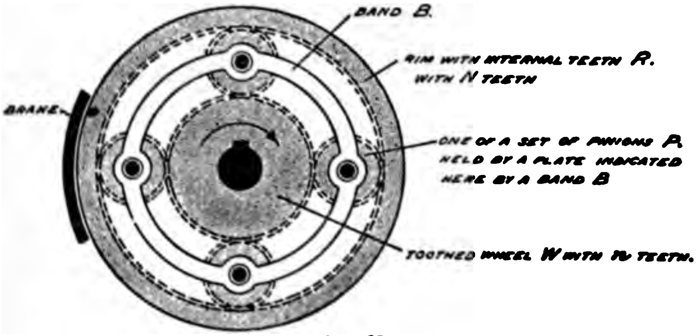


Fig. 67.

The inner wheel, *W*, driven by the motor-shaft, will rotate the rim, *R*, at the same speed as itself, unless *R* is held by the brake, in which case the entire set of pinions, *P*, will be revolved by *W* carrying with them the band, *B*, but at much slower speed than before. The rim, *R*, and the band, *B*, take the form of plates connected to the driving-sprocket, in practise. (See Fig. 68.)

spur-wheel on the counter-shaft a third pinion, which converts the second-motion shaft into a third-motion shaft, making it revolve in the same direction as the main shaft. (See Fig. 66.)

Attempts have been made, with greatest success on light carriages, to employ a speed-change mechanism which would do away with the necessity of threadling the teeth of one pinion into the spaces of another, while both are in motion. One method is to have the spur-wheels constantly enmeshed, but running idle until brought into action by a system of positive or friction-clutches. The

simplest system is the epicyclical or crypto-gear, in which the pinions are always in mesh in the same way as in the differential gear, and are brought into use by the operation of the band-brake. (See Figs. 67 and 68.)

One of the earliest problems encountered in construction of self-propelled vehicles was that of making short turns possible without skidding. In the horse-drawn vehicle, where the motive power is exerted by a pull on the front axle, and both axles are "dead," allowing the wheels to rotate at

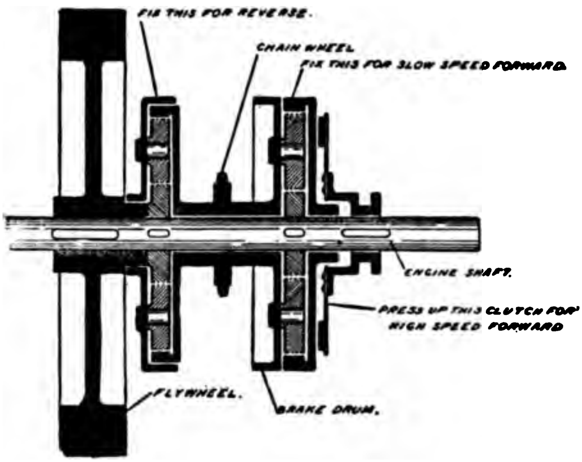


FIG. 68.—SECTION OF AN APPLICATION OF PLANETARY TRANSMISSION OR CRYPTO-GEAR GIVING TWO SPEEDS FORWARD AND ONE REVERSE.

different speeds when necessary, this problem is easy. The early attempts to solve the problem in motor-vehicles led to the application of the power to a single forward wheel, as in the Cugnot car-

riage, or to the employment of a tractor—a separate motor-truck taking the place of the horse and the forward wheels. Driving, however, on the forward axle proved impracticable, and modern

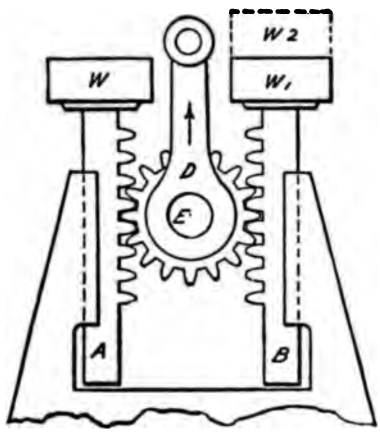


FIG. 69.—PRINCIPLE OF DIFFERENTIAL GEAR.

If the racks *A* and *B* are weighted equally by *W* and W^1, a lift on *D* will raise the whole evenly without rotating wheel *E*; but if *B* has more weight than *A* then *E* will rotate, lifting *A* only.

automobiles, except a few old-style electric cars, apply the power to the rear axle, steering with the forward wheels. In traveling in a straight line, it is, of course, desirable that the power should be applied equally to both wheels, but if this were the case in making a sharp turn, the resistance encountered by the inner wheel would set up an undesirable strain and cause the wheels to skid or slip sideways. To obviate this a separate motor for each wheel might be employed, as in electric vehicles. The device almost universally adopted, however,

is the differential or balance gear, the principle of which may be understood from Fig. 69. The differential, as applied to automobiles, is illustrated in Fig. 70. In this form it may be applied to the rear axle, which is then divided; or it may be applied to a separate shaft as shown in Fig. 66.

In practise, however, the structural weakness involved in a divided axle-shaft is eliminated by attaching one wheel to a hollow sleeve which works over the "live" axle to which the other wheel is attached in the usual way. One-half of the differential is attached to this sleeve and the other at a point generally about midway of the solid shaft.

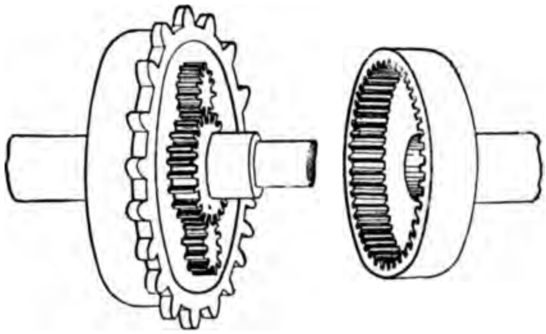


FIG. 70.—DIFFERENTIAL WITH PLANE PINIONS.

If the resistance on both wheels is equal, the small pinions will not revolve, but will carry both wheels around; if either wheel encounters greater resistance than the other, the small pinions revolve.

Sometimes two sleeves are employed, one for each wheel. One vehicle, the Riker Electric, is constructed with box-hubs, in one of which the differential gear is enclosed.

The transmission system as a whole is generally arranged in one of two ways. The motor-shaft drives the main shaft by clutch. From the main

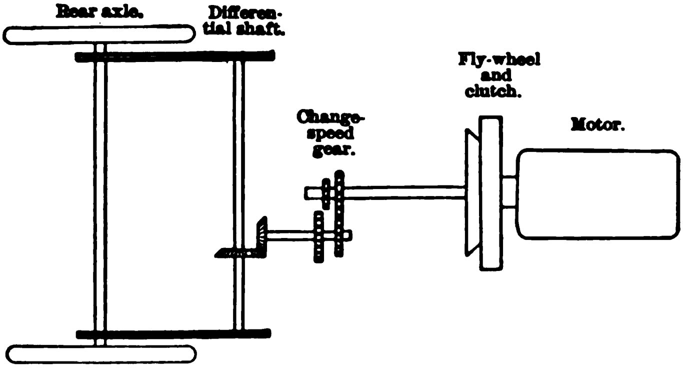


FIG. 71.—TYPICAL FRENCH SYSTEM OF TRANSMISSION TO "DEAD" REAR AXLE.

shaft with its speed-change gear the power is transmitted:

(1) By bevel-gears or chain to the counter-shaft set across the frame of the car and containing the differential gear. From each end of this counter-shaft there is a chain and sprocket to the wheels, which are set on a dead axle. This is the typical French system. (See Fig. 71.) The drive from the speed-gears may be:

(2) Through a universal-jointed longitudinal shaft by bevel-gears direct to a live rear axle containing the differential. (See Fig. 72.) This, formerly the common American practise, is being abandoned in favor of the foreign system.

Steam-automobiles may drive direct from motor-shaft to live rear axle containing the differ-

ential, transmission being either by chain and sprocket, as in the Gardner-Serpollet car, or by bevel-gears and universal-jointed shaft, as in the White car. Or a counter-shaft may be introduced, the drive being from this to a live rear axle or to the wheels on a dead rear axle. Speed-change gears are generally dispensed with, and if employed are much simpler than in gasoline-cars. In electromobiles the armature-shaft is usually geared directly to the live axle with differential, speed-change being entirely provided for by the controller. Drive may be on the forward wheels, but this is not now considered good practise. The preferred system is to have two motors, one geared

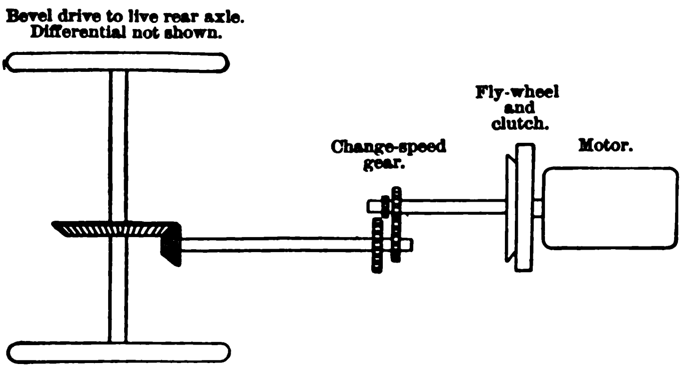


FIG. 72.—TRANSMISSION BY SHAFT TO LIVE REAR AXLE.

directly to each of the rear wheels, dispensing with the differential.

Like turning, steering is quite a different matter with an automobile than with a horse-drawn vehicle. It might seem that the ordinary swinging

front axle could be readily turned by means of a lever in the driver's hands; and such an adaptation was not long since abandoned by Panhard-Levassor on one model of their voiturette. The difficulty

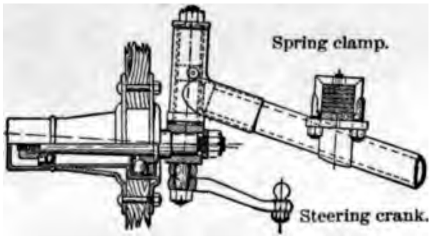


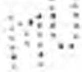
FIG. 73.—KNUCKLE-JOINTED STUD-AXLE WITH PIVOTS OF THE LEMOINE TYPE AS EMPLOYED ON PIERCE CAR.

is chiefly one of control. When either wheel of the pivoted front axle meets an obstacle, in the absence of shafts or tongue to steady it, there is a strong tendency of the axle to spin around on its pivot, which, even with screw transmission from the steering-handle, causes too much strain to be safe. As early as 1818, Rudolph Ackermann, of London, patented the invention of Lankensperger, of Munich, which consisted of a rigid front axle-shaft, at either end of which the wheels were pivoted by knuckle-jointed stud-axles. A modern type of these is shown in Fig. 73.

As the carriage turns, the inner wheel must always be swiveled farther in the direction of movement than the outer. If both stud-axles made the same angle with the main axle the wheels would be parallel, as in running straight ahead. The

NON-REVERSIBLE STEERING-GEAR OF THE WORM AND SEGMENT VARIETY, AS ADAPTED BY THE BROWN-LIPE COMPANY.

KNUCKLE-JOINTED STUD-AXLE, SHOWING CONNECTING-ROD AND SPRING SUSPENSION, AS EMPLOYED ON THE PACKARD CARS.



outer wheel would tend to describe too sharp a curve, and would consequently skid.

In order that a rear-driven vehicle may turn properly, the tracks described by all four wheels must be concentric arcs; and in order to secure this the stud-axle must be turned in such a way that if their axes were prolonged they would meet on a point on the axis of the rear axle. This was not provided for in Ackermann's system until modified by Jeantaud in 1878, as shown in Fig. 74. Instead of having the connecting-rods, *O L* and *O′L′*, at right angles to the stud-axles, as Acker-

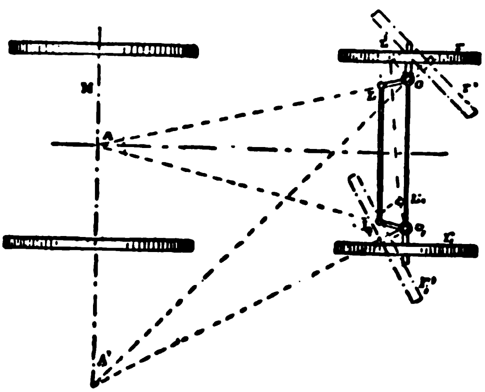


FIG. 74.—PRINCIPLE OF THE STEERING ANGLE IN THE ACKERMANN-JEANTAUD SYSTEM OF PIVOTED STUD-AXLES.

O O′, pivoted stud-axles; *r r′*, wheels, relative positions in turning shown in outline; *O L* and *O′ L′*, steering cranks of stud-axles.

mann had done, Jeantaud placed them at such an angle that if prolonged they would meet on the rear-axle axis, *M*, at its intersection, *A*, with the median line of the car. While, theoretically, it

should be possible, by some system of hinged connecting-rods like Jeantaud's, to secure the revolution of all four wheels in concentric paths, practically, good results are not obtained for turns

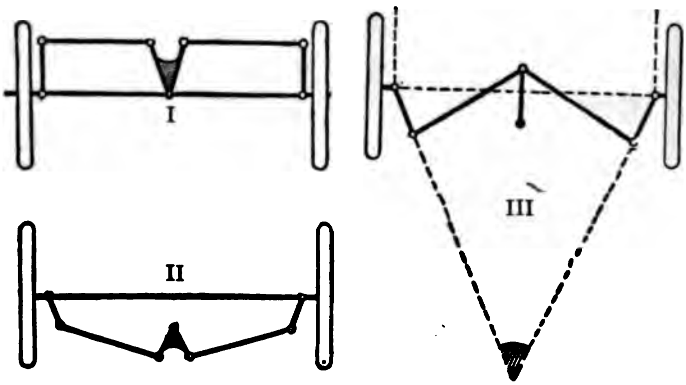


FIG. 75.—TYPES OF COUPLINGS OF CONNECTING-RODS FOR STEERING.

The steering angle is shaded. I. Jenatzy double quadrilateral. II. Bollée double quadrilateral. III. Lavenir concave pentagon.

sharper than 40°, because beyond this it is possible only to approximate without too complex an arrangement of rods.

Rods are coupled in different ways denominated by the geometrical figure their arrangement forms. (See Fig. 75.) It is usual to fix the quadrilateral formation in front of the axle rather than behind it, as this gives a greater efficient steering-angle and better equalizes the strain of jolting. The single quadrilateral is almost entirely superseded by the double, with rotary axis either on the axle or taking a variable parameter. This has been

further modified in a concave pentagon form, which is the most accurate system yet devised.

Several methods of operating the connecting-rods are shown in Figs. 76–78. Chain transmission (Fig. 76) is not commonly employed alone, as it does not give sufficient irreversibility, hence taking up too much of the driver's attention and energy. The simplest method of making the action of the steering-gear non-reversible is the worm-screw as applied in the Panhard worm and sector (see Fig. 77) or in the Brown-Lipe back-locked gear. (See Fig. 78.)

In order to secure as efficient leverage as possible, the pivot of the stud-axle should be fixed as near

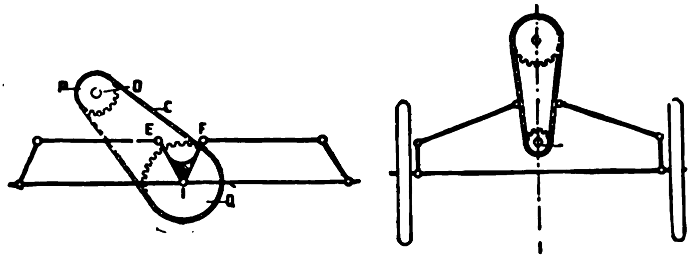


FIG. 76.—OLD FORMS OF CHAIN-STEERING TRANSMISSION.
The pinion, *Q*, concentric to sector *E I F*, is moved by chain *C* and smaller pinion *P*, securing demultiplication.

the wheel-center as possible. This is, of course, most perfectly accomplished in the bicycle-fork, which has been employed in three-wheel carriages and occasionally on light four-wheel cars. Various means are employed to attain this result. The wheel may be "dished" (Fig. 79) so that the tire

strikes the road directly in line with the pivot of the knuckle-joint. Or the joint itself may be inclined so that its axis if prolonged would intersect the tire track. (See Fig. 73.)

Brakes, to be efficient, should give the maximum of resistance with the minimum of power exerted at the lever, and should be instantaneous and positive in operation. Shoe-brakes act by pressing a block of suitable material against the tires or against drums forming one with the wheel. They admit of a relatively long lever-arm, and hence

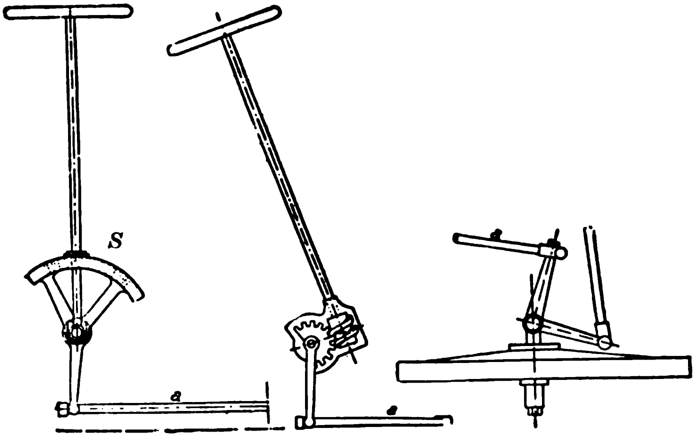


FIG. 77.—PRINCIPLE OF THE NON-REVERSIBLE WORM AND SEGMENT STEERING GEAR.

The toothed sector, *S*, draws the bell-crank rod, *a*, as the hand-wheel is turned.

give considerable power, though simple and reliable in mechanism. They are most useful on grades, or wherever it is desirable to control the movement of the car without suddenly stopping it.

Band-brakes operate on drums attached to the counter-shaft or to the driving-wheel. Both systems may be employed, the one operated by pedal,

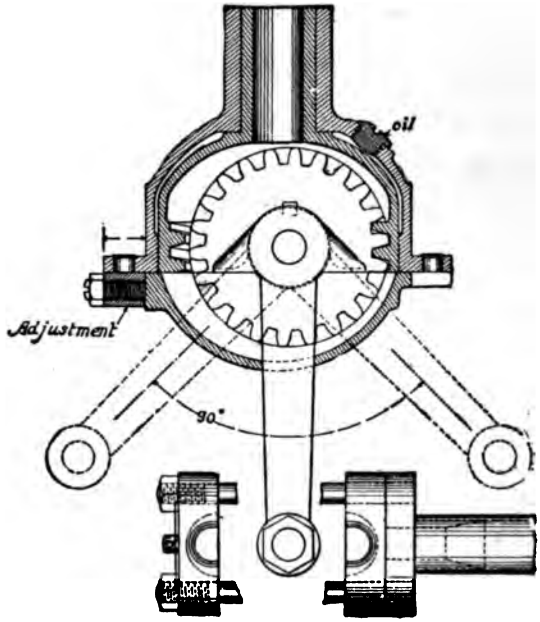


FIG. 78.—CROSS-SECTION OF BROWN-LIPE BACK-LOCKED STEERING GEAR.

the other by hand-lever. Band-brakes may be arranged to operate only for forward motion, or for both forward and backward motion. (See Fig. 80.) The steel band covered with leather or camel's hair generally extends over about three-quarters of the circumference of the drum. Where two brakes are employed one should operate to release the clutch

automatically. Vehicles whose brakes do not prevent backward motion are often provided with a

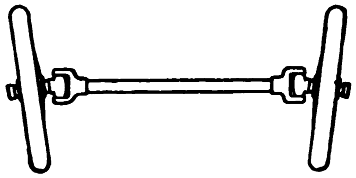


FIG. 79.—DISHED WHEELS TO SECURE LEVERAGE IN STEERING.

pawl to be brought into contact with a ratchet on the driving-wheel or with a sprag or prop which trails behind in hill-climbing. The use of band-

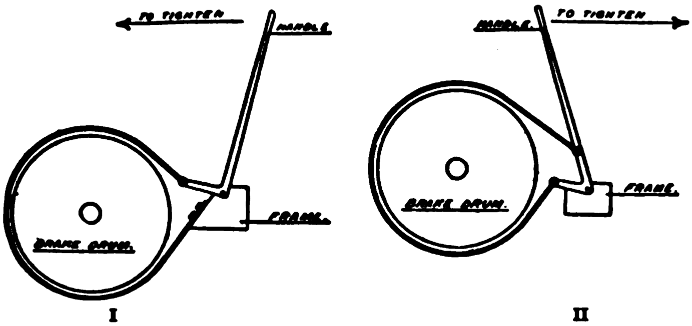


FIG. 80.—TWO CONSTRUCTIONS FOR BAND-BRAKES.

I, band tightens only when wheel is moving forward; II, band tightens whichever way the wheel rotates.

brakes operating in both directions and requiring a moderately strong pull for full action, is practically standard practise.

CHAPTER VI

THE CHASSIS

The strict meaning of the French word *chassis* is the frame of the vehicle, or the frame on its springs. The word has become Anglicized, and is so taken as denoting the frame and all mechanisms exclusive of the carriage-body. It sometimes has this meaning also in French.

The chief ends sought in the framework of motor-carriages are, of course, lightness and strength. There must be a proper balance between rigidity and flexibility, so as to neutralize, as far as possible, the effects of vibration, not only from the unevenness of the road, but from the operation of the motor. The main or underframe is the medium to which are attached the wheel-axles below, thus forming a support for the carriage-body and machinery. In early construction a framework of steel tubing was considered almost essential to secure the desirable combination of strength and lightness. Experience has shown, however, that the reduction in weight is more than offset by the greater complexity of the structure, so that there is an increasing tendency toward the employment of angle-iron frames (Fig. 81), constructed as

nearly as possible in accordance with ordinary carriage-building methods. An authority states that in a 4,900-pound cab, tubular framework saves only about 200 pounds' weight. Obviously, considera-

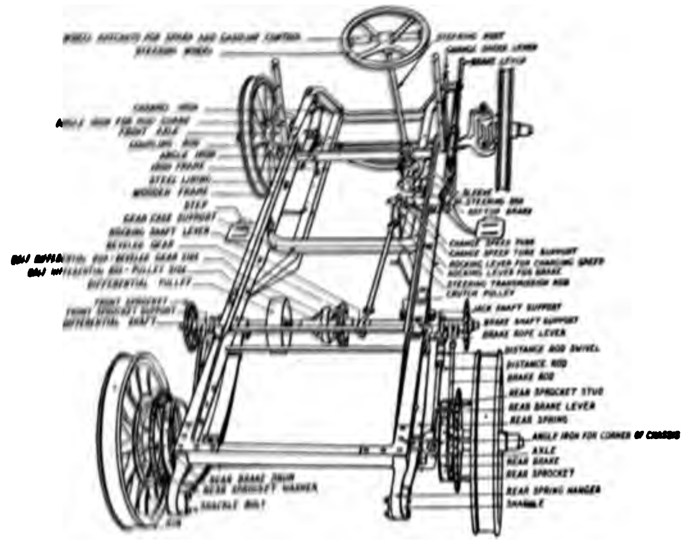


FIG. 81.—PANHARD CHASSIS, WITH STEERING, BRAKE, AND CHANGE-SPEED TRANSMISSIONS, SHOWING ANGLE-IRON FRAME AND SPRING SUSPENSION.

tions of lightness must be based upon the power of the driving mechanism, and when this power is sufficient to propel a car of definite weight, there is no gain in efficiency by reducing the weight below the limit of adequate support for the mechanism.

An additional advantage in adopting standard carriage construction, so far as possible, throughout the vehicle, is that repairs are rendered easier

and more available, those with tubular frames requiring special mechanics. The general contour of the underframe, whatever its material, is usually four-sided, flexibility being secured in general by various systems of swivel-jointing, enabling the wheels to run, within limits, on different planes. (See Fig. 82.) Quite a number of carriages secure this end by three-point suspension, where the forward axle-shaft is joined to the underframe by a single swivel-joint. (See Fig. 83.) The objection urged against this is that one spring must compensate for all the jar due to unevenness of the road. With a suitable adjustment of springs, however, the arrangement is said to give good re-

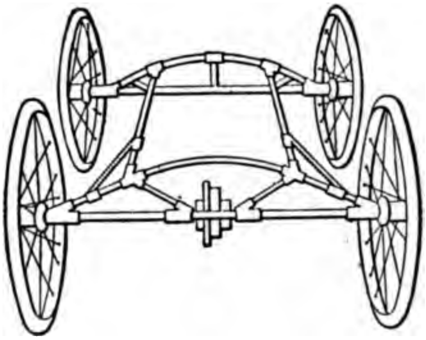


FIG. 82.—STANLEY TUBULAR FRAME USED ON A NUMBER OF LIGHT CARS.

sults. The present tendency is toward the simplest possible construction for underframes, and to make the same framework answer, so far as possible, as a support for body, motor, and running-gear. One American manufacturer, at least,

dispenses with underframes altogether, hanging the axle-shafts directly to the springs, placing the motor within the body.

The adjustment of springs on automobiles is a difficult problem, because one of its most im-

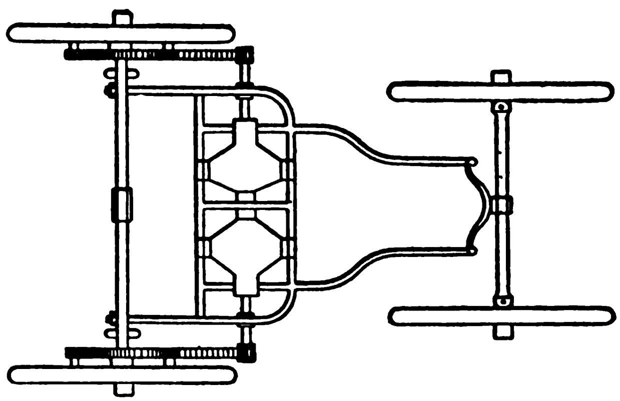


Fig. 83.—A Tubular Frame for an Electric Car, showing Three-Point Suspension.

portant factors, namely, the road, is so uncertain. Three general systems of suspension are employed.

The main frame (1) is supported upon the axles by springs, the body and machinery being rigidly attached to it. Here the transmission must be flexible enough for the motor to follow any displacement. The frame (2) may be attached to the axles carrying the machinery and the body be suspended above it by springs. Here the passengers are relieved from motor vibrations, though the motor itself is exposed to jolts. A double set of springs

(3) may be used, one supporting the frame and the other the body above it. This is, theoretically, the best construction, but is not much employed, as it complicates the car.

Since the tendency to a backward or forward throw of the rear axle is much greater in self-propelled vehicles, the springs are usually set with the length of the car instead of across it. Leaf-springs (Fig. 84) seem to give the best results in automobile construction, and can be most readily calculated to meet the conditions of travel. As the purpose of springs is to absorb the jolt, they should be constructed to return as quickly as possible to their original shape. Thus heavy springs, within limits, give easier riding than light springs, since they do not transmit so readily the cumulative bouncing, which even with pneumatic tires is not overcome sufficiently by light springs. Leaf-springs are

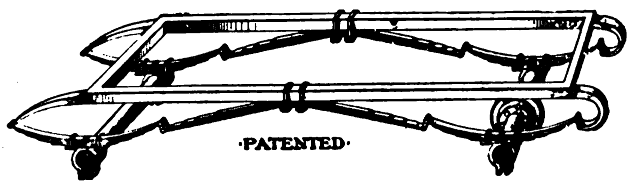
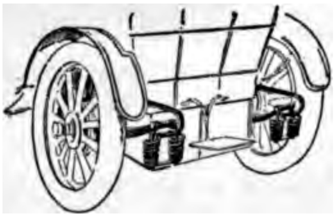


Fig. 84.—The Hill Suspension, showing Semielliptical Leaf-Springs and Methods of Attachment to Frame.

always attached to their supports by clamps and nuts rather than by bolts directly through them. The ends of the springs are usually attached by links to afford ample freedom in lengthening. Quick recovery of the springs without subsequent

oscillation is the prime essential. Semielliptical springs (see Fig. 84) are preferred by some authorities, on the ground of greater elasticity, which is held to be proportional, within limits, to the length of the spring.

Spiral springs are rarely used alone to support a portion of the car, but are sometimes employed



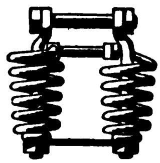


FIG. 85.—SUPPLEMENTARY SPIRAL SPRING COMPANY'S SYSTEM OF ABSORBING EXCESSIVE VIBRATION FROM THE SIDE-SPRINGS.

as auxiliary to the main spring. (See Fig. 85.) Various supplementary devices are employed to absorb shock, the general principle of these being to correct the uneven action of the main spring, which has a tendency to fly back too far, since the friction of the leaves decreases with the tension of the spring, allowing it to go too far in the opposite direction, which tends to set up an undesirable oscillation or bouncing. (See Fig. 86.)

The wheels of self-propelled vehicles must have, above everything else, solidity. With a load twice as heavy, and a speed three times as great as the horse-drawn vehicle, the automobile requires wheels eighteen times as strong. It is desirable to have as much elasticity as possible between the com-

ponent parts of the wheel, and for a time this was sought in the use of wire wheels, which sustain a heavier load in proportion to their weight than do wooden wheels. They will not, however, endure nearly as great side-thrust as wooden wheels, and as this is the vital consideration in calculating wheel-strength, the modern type of artillery wheel has practically superseded them. The nave of the wheel is usually of bronze. It sometimes is customary to dish the wheels, that is, to set the spokes at an incline instead of at right angles to the hub. This gives greater elasticity against side-thrusts, and is usually balanced by inclining the axle (see

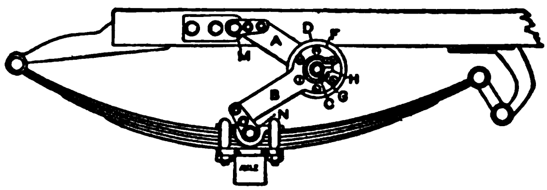


Fig. 86.

Truffault-Hartford auxiliary suspension, for absorbing shocks, consisting of two arms, *a* and *b*, held in frictional contact by bolt *c*. Oil-soaked rawhide is screwed between the plate *f* and bronze shell *d* by means of nut *g*, locked by a collar *h*, thus giving variable adjustment. Cone-like frictional joints, *m* and *n*, on frame and axle are also adjustable.

Figs. 73 and 79) so that the lowest spoke is as nearly vertical as possible with relation to the ground.

The diameter of automobile wheels is much smaller than that of horse-drawn vehicles. Large wheels have several advantages, giving greater leverage in overcoming resistance, both at the jour-

nal and at the tire, sinking less deeply into depressions in the road, consequently reducing jolts and passing more readily over obstructions. They also tend to wear the road less and to raise less dust. Large wheels can not, however, be made as solid, in proportion to their weight, as small wheels. Furthermore, ease of running can be secured with the latter by increasing the width of the vehicle, also that of the tires, and by properly calculating the length of the springs. Broad tires, particularly, offset the disadvantages of small wheels, so that their use has made possible the employment of wheels considerably under three feet in diameter as the general practise. There are no definite data as to efficient tire-width, this being calculated all the way from one inch for every 218 pounds, to one inch for every 700 pounds of load. The pivoted stud-axle method of steering does not necessitate smaller front wheels, as in horse-drawn vehicles, and it is considered good practise to have all wheels of a car of the same diameter, making possible better distribution of load. Solid metal wheels or wheels with solid steel segments instead of spokes are sometimes employed.

Experience has proved the use of rubber tires imperative for automobiles in order to secure efficient traction. With power applied directly to the wheels, it is impossible to secure this with metal tires unless the load is balanced directly over the driving-wheels. The additional vibration caused by the machinery would alone call for the

use of resilient tires. A type of solid rubber tire is shown in Fig. 87, together with a method of attaching it to the rim. To reduce the tendency of cuts and tears to spread toward the center, such tires are made with bevel edges and with more or less rounded contour, as shown in the figure. This also helps to absorb vibration. Solid tires are often compound, having their interior of more elastic material than the exterior. Cushion tires, a variation consisting of simply a hollow rubber tire with relatively small air-space incapable of inflation, do not offer resistance enough to the heavy weight of automobiles, so that they do not afford any advantage in resiliency.

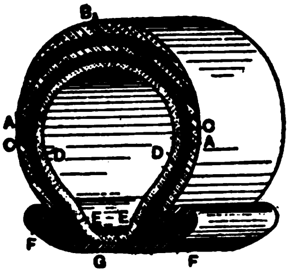
FIG. 87.—FIRESTONE SOLID TIRE, SHOWING ATTACHMENT TO RIM BY SIDE-WIRES.

It seems to be the generally accepted opinion that the advantages both in traction and resiliency of pneumatic tires more than compensate for their alleged inferior durability and increased liability to inconvenient punctures. It has been demonstrated that, with equal load, the wheel with most elongated contact rolls most readily.

With a rigid tire, length of contact at the road surface varies only with the diameter of the wheel. With equal diameters, therefore, a rubber tire will adjust its area of contact in proportion to the load, offering less resistance to rolling by virtue of its

tendency to spread out rather than cut into the road. Evidently, in this respect, the pneumatic tire is superior to the solid. But while it gives greater longitudinal contact, it also has the disadvantageous tendency to expand transversely. Hence, under certain conditions, the tractive resistance may be greater with pneumatic tires than with solid, this being largely a question of the best degree of inflation. The normal pressure in the air-chamber varies from 56 to 85 pounds per square inch, but experience relative to varying road conditions can be the only reliable guide in the absence of definite scientific tests. The superior resiliency of pneumatic tires is most apparent in their absorption of vibrations incident to high speed, and since speed is one of the main aims in automobile construction, this consideration alone is enough to account for the extensive use of pneumatic tires. The chief qualities to be obtained in the structure of pneumatic tires are a tread of sufficient thickness to resist puncture; sufficient reenforcement of the side walls to insure longitudinal rather than transverse deformation and to prevent wear at the points of contact with the rim.

Pneumatic tires are therefore constructed with different reenforcing fabrics, as illustrated in Fig. 88. Pneumatic tires, especially when slightly deflated, tend to creep around the wheel-rim, sometimes causing rupture at the valve. Hence various means are employed to secure rigid attachment to the rim. Double-tube pneumatic tires have the

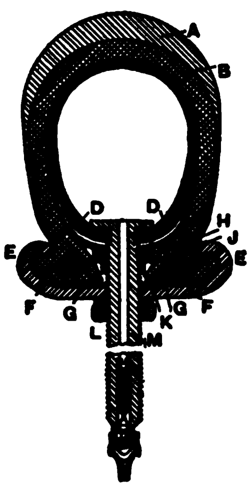


DUNLOP TIRE.

A, outer cover; *B*, fabric; *C*, thick canvas; *D*, inner tube; *E E*, hard rubber; *F*, cover bead; *G*, rim.

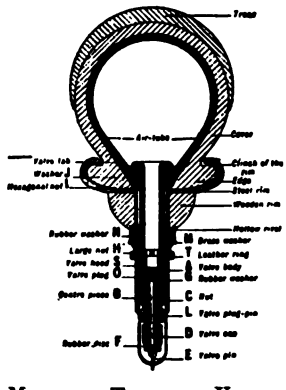
GOODYEAR TIRE.

A A, thick rings of solid rubber of outer cover held by rims and bolts, *B*; *C D*, bolts securing rim to wheel; *W*, thin woven wires; *J*, fabric; *K*, inner tube.



GOODRICH CLINCHER TIRE.

A, outer cover; *B*, canvas; *D D*, points of cover specially thick and strong; *F F*, hard-rubber clinchers; *G*, rim-protection strip; *H*, washer; *T*, bridge; *K*, bridge-nut; *L*, lock-nut; *M*, valve-stem; *E*, rim.



MICHELIN TIRE AND VALVE.

FIG. 88.—FOUR TYPES OF PNEUMATIC AUTOMOBILE TIRES.

outer layers of rubber and fabric so constructed as to best resist wear and deformation, while the inner air-tube of pure rubber is calculated with regard to efficient inflation and retention of air. Single-tube pneumatics have this inner tube vulcanized to the outer, rendering repairs easier, without, it is claimed, reducing their elasticity.

Lubrication of the various parts of an automobile is by no means a simple problem. The parts

FIG. 89.—A TYPE OF SIGHT-FEED LUBRICATOR.

to be lubricated are numerous; many of them are inaccessible when the vehicle is in motion, and it is highly desirable to be able to regulate the amount of lubrication to a nicety in order to minimize undesirable friction. The motor-cylinders, bearings of the valve-rods, all distributing and regulating mechanisms such as pump, fan, dynamo, magneto, speed-change, and differential gears, steering-gear, all lever-hinges, as well as the wheel-axles, naturally suggest themselves as not only requiring lubrication, but requiring it in different kinds and

degrees. The oxidizing point of temperature in oil for use in a gas-engine cylinder must be higher than the highest temperature of the lubricated surface. Its flash-point must therefore be not less than 360° F., and it must withstand a fire-test of at least 420°. It was not until the superiority of mineral oils in this respect came to be understood that the lubrication of the gas-engine could be said to be practicable. The oil must not only not become thin at high temperatures, but must not congeal at ordinary low temperatures.

Owing to the high speed of the gasoline-motor, some other force than gravity must be employed to insure a sufficient and continuous flow of lubricant to the parts requiring it. One drop of oil per minute is sufficient lubrication for a 500 H. P. steam-engine, while an ordinary gasoline-motor for automobiles must have from six to eight drops per minute. On the other hand, too much lubricant in the cylinder interferes with the quality of the explosive mixture.

Lubricating systems depending upon gravity, condensation of steam, suction of pistons, etc., are not reliable unless their working can be watched and regulated as required. Mechanical lubricators, worked by hand or automatically, are essential with multiple-cylinder, high-powered motors. The most common system employed is a pump, geared to the motor, and forcing the oil through sight-feed tubes, which are in front of the driver and can be regulated to give the proper supply to each part.

(See Fig. 89.) Oil is fed into the crank-case, from which it is splashed over the parts by the movement of the crank. In horizontal motors it is possible to adapt the ordinary oil-cup and to control the feed by mechanical pressure.

CHAPTER VII

TYPES OF THE GASOLINE-MOTOR

Any attempt to classify the various types of motor employed in the construction of vehicles must be more or less artificial. The early development of motor construction, especially in America, has produced a multiplicity of widely different designs, and only now is some effort being made by manufacturers to conform in the main features to some standard practise. For instance, it is generally recognized that the cylinder including explosive and valve chambers should be made in one casting, to avoid all joints back of the power-face of the piston. On the other hand, the application of the principles of construction, outlined in a preceding chapter, differs in regard to the number and position of cylinders, the operation of valves, method of cooling, the manner of ignition, etc., only in points which tend to increase efficiency and make possible more complete control.

In early Daimler motors the piston stroke was long in proportion to the diameter of the piston, thus securing very high compression. Experience has proved, however, that a stroke more nearly equal in length to the piston diameter reduces vi-

bration. The longest stroke employed by any American motor reaches the ratio of 7 to 5. Several American motors have a stroke shorter than the piston diameter.

The original Daimler V-shaped motor, with ratio between piston diameter and stroke of 3 to 5 developing at most 4-horse-power, has reached a wonderful development in modern multiple-cylinder construction.

In general, it may be said of modern high-powered motors that the cylinders are four in number; that the inlet valves are mechanically operated and usually interchangeable with the exhaust-valves; that the sparking-current is furnished by a motor-driven dynamo or magneto, or by the Simms-Bosch low-tension magneto; that the lubrication is by sight-feed, hand-regulated pressure system; that cooling is by pump-circulated jacket-water, with radiator usually fan-cooled. Variations in these particulars are shown for a number of the best-known motors in the following:

The Panhard motors are constructed with two, three, or four cylinders, according to the horse-power desired. The three- and four-cylinder motors have the cylinders cast separately, so that each can be turned in the lathe and its weight reduced to a minimum without sacrificing strength. Motors of 24 H. P. and over may have the cylinders of wrought steel, still further reducing weight. The two-cylinder motors have the cylinders cast in pairs. The three-cylinder motors give 8 H. P.

From 24 H. P. up a system of expansible cams provides for volume-throttling on the inlet valves. On motors of 15 H. P. and above, all valves are mechanically actuated. On the 50 H. P. four-cylinder motor, a new system of governing is substituted for the centrifugal method, the pressure of the

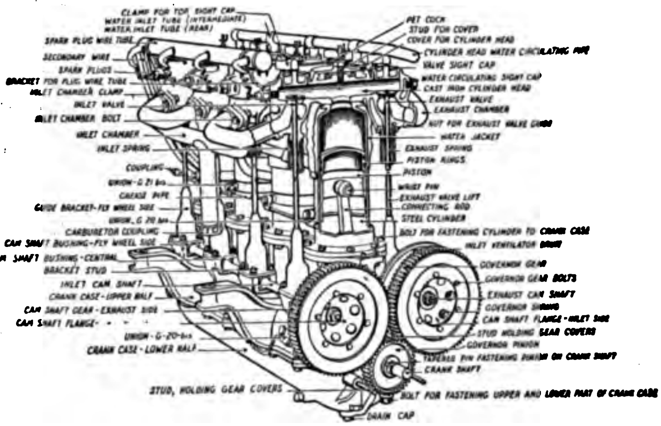


FIG. 90.—PANHARD FOUR-CYLINDER MOTOR.

water circulation, when the engine attains a certain speed, operating to slightly close the throttle-valve. Ignition is by jump-spark, current being furnished by motor-driven magneto, with storage-battery auxiliary. (See Fig. 90.)

The Mercedes (German Daimler) motors, rated at 28 to 32 and 40 to 45 H. P. according to dimensions, have four vertical cylinders, cast with their water-jackets in pairs, all valves being mechanically operated, a practise which originated with this concern and is now standard for high-powered

motors. The inlet-valves were formerly situated at the top of the cylinders but are now at the side. Ignition is by Simms-Bosch magneto. Cooling is by water-circulation, with honeycomb radiator and fly-wheel fan, a system also original with this motor. The exhaust is led to a silencer at the rear of the car, which can be cut out when desired, giving additional power.

The Rochet-Schneider 24 to 35 H. P. motor has four cylinders cast in pairs. The 35 to 50 H. P. motor has four individual cylinders. Fly-wheel is made of soft steel and is of the hollow or spoked type. Ignition is by low-tension magneto, the spark being produced by a peculiar system of contact, employing cam-actuated tappets.

The Renault 20 to 30 H. P. motor has four vertical cylinders cast in pairs. Valves are mechanically actuated, both on same side of cylinder, and operated by single cam-shaft, which is cast solid with the cams. Ignition is by both jump-spark and Simms-Bosch magneto. Cooling is by the thermosiphon system, with radiators and fly-wheel fan.

The Peugeot 18 to 26 H. P. and 30 to 40 H. P. motors have cylinders cast with water-jackets in pairs, mechanically actuated valves on opposite sides of the cylinder, both Simms-Bosch and jump-spark ignition, interchangeable by means of a switch on the dashboard. Cooling is by gear-driven pump forcing the water circulation through a honeycomb radiator cooled by a fan.

The Decauville 45 to 60 H. P. motor has four

vertical cylinders, all valves mechanically operated and interchangeable, ignition by jump-spark, with both magneto and batteries interchangeable, cooling by water circulation through radiator with fan, governing by variable lift of the admission valves.

The Clement-Bayard 45 H. P. motor has four separate cylinders with mechanically operated, interchangeable valves, water-cooling, with honeycomb radiator, and jump-spark ignition with magneto current.

Among some American manufacturers there is a tendency toward employing a system of air-cooling for high-powered four-cylinder motors, by means of a motor-driven rotary fan. Thus the Franklin, claiming to be the first four-cylinder motor-car manufactured in America, employs air-cooling entirely for its 20 H. P. and 30 H. P. motors. A notable feature of the Franklin motor are the auxiliary exhaust-ports (see Fig. 91) opening into small chambers with external radial ribs. These chambers contain check-valves, so that the exhaust from one cylinder can not enter another when its piston uncovers the port at the end of the stroke, as shown in the figure. The main exhaust-valves and the inlet valves are both situated in the cylinder-head. The advantage claimed for the auxiliary exhaust is that, being open slightly before the main exhaust, back-pressure is entirely prevented, and a greater amount of heat is carried from the cylinder than would be the case if the entire exhaust passed through the main valve.

Radiation of heat from the cylinders is assisted by a gear-driven fan.

Newton's law of cooling, given by him for a body "not in still air but in a uniform current of

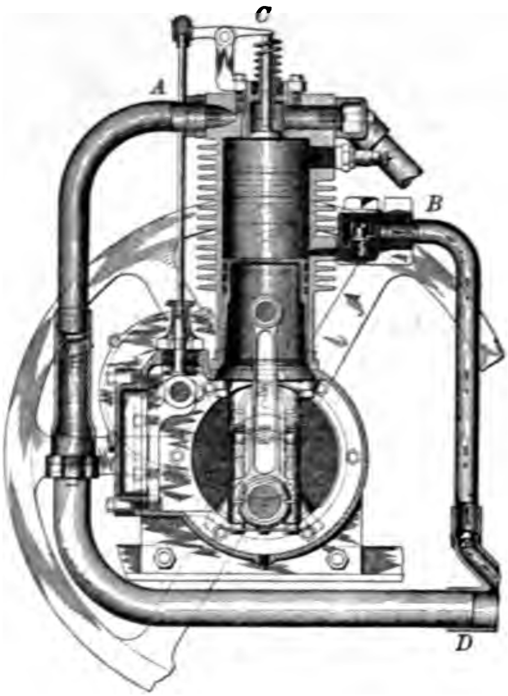


FIG. 91.—PLAN OF FRANKLIN MOTOR, SHOWING AUXILIARY EXHAUST-PORTS.

A, main exhaust; *B*, auxiliary exhaust-port; *C*, admission-valve; *D*, connection of auxiliary exhaust-pipe to main exhaust-pipe.

air," is, roughly, that the rate of cooling is in direct proportion to the speed of the air-current. Experiments have shown that this law is fairly accurate up to a temperature excess of 200° C. and

a speed of air-current up to 1,000 meters per minute.

In the Frayer-Miller four-cylinder 24 H. P. motor (see Fig. 92) each cylinder is surrounded with an aluminum jacket open at the bottom. A current of air from a centrifugal blower is carried

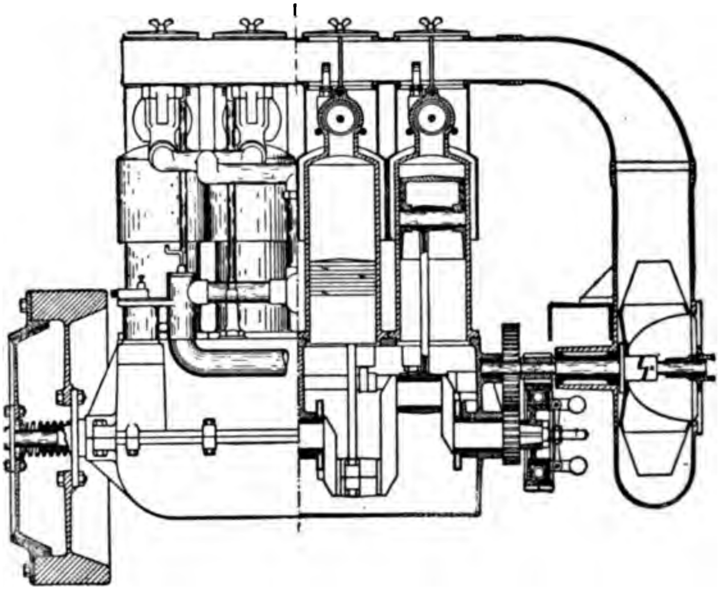


FIG. 92.—THE FRAYER-MILLER SYSTEM OF AIR-COOLING, IN WHICH SPEED AND PRESSURE OF AIR-CURRENT ARE BOTH REGULATED.

by an aluminum bustle-pipe to the top of the jackets. Innumerable spikes are cast on the outside of the cylinders, over which the air is blown at constant speed and at a pressure of about two ounces per square inch. The employment of this air-jacket makes it possible to predetermine the speed and

pressure of the air-current to the highest efficiency. This is scientifically correct, for, when the speed of cooling becomes independent of pressure, there are no convection currents, and cooling is due to conductivity alone.

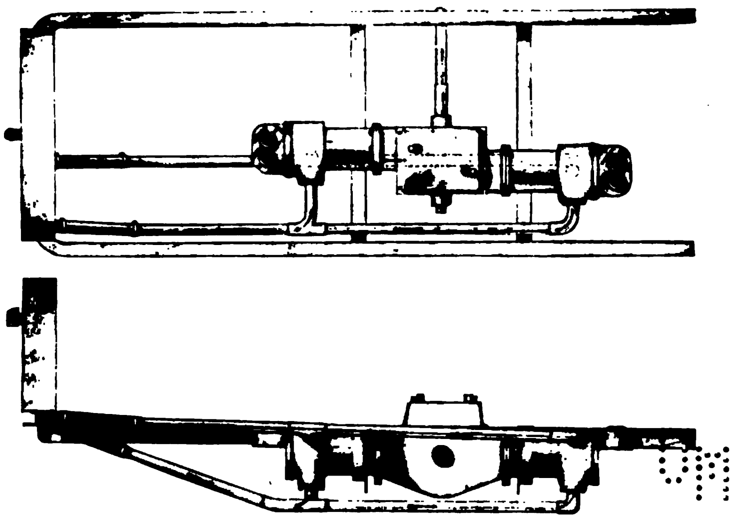
The inlet and exhaust valves are on opposite sides of a chamber cast in the top of the cylinder just wide enough for the movement of the valves (see Fig. 93). Hence the fresh charge of cool gases must pass over the exhaust-valve head helping to cool it. It is recognized as good practise to take advantage of the lower temperature of the fresh mixture in this way, and it is done in a number of motors.

The Corbin 16 to 20 H. P. four-cylinder air-cooled motor augments radiation from the cylinders by a series of comb-shaped blades punched from soft wrought steel, the surface of which is treated by a special process. The blades are then inserted into grooves in the outer cylinder walls, the cylinder metal being " peened " into recesses in the base of the blades in order to make them practically integral with the cylinder.

In the larger cars the blades are parallel with the cylinder and two fans are placed over the cylinder-heads. In the smaller cars the blades run lengthwise of the cylinder, and a single fan is placed in front.

Other four-cylinder air-cooled American motors are the Premier 16 to 18 H. P., the Duquesne 16 to 21 H. P., and the Marmon 20 H. P.

PATENTED SYSTEM OF PIN-RADIATION ON AIR-COOLED CYLINDERS OF THE KNOX CARS.



PLAN VIEW AND ELEVATION OF THE THERMO-SIPHON SYSTEM OF WATER-COOLING, AS EMPLOYED ON THE RAMBLER AUTOMOBILES.

The Marmon motor embodies some interesting features. Like the Ader (English) four-cylinder 24 H. P. motor, the cylinders are inclined at an angle of 45° from the vertical, or 90° from each other. The cylinders with radiating flanges are

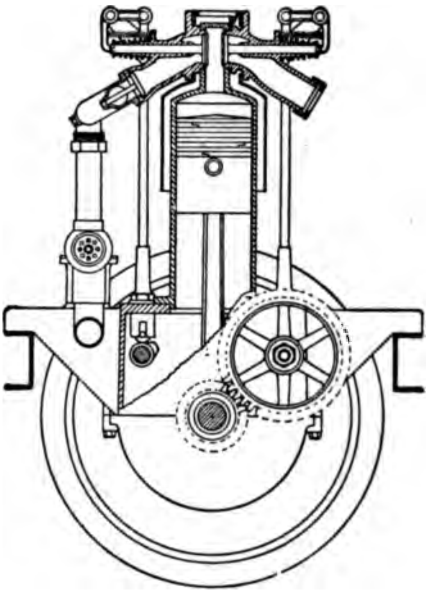


FIG. 93.—CROSS-SECTION OF THE FRAYER-MILLER MOTOR.

cast separately. A belt-driven fan supplies a draft of air which has free circulation to the rear of the car.

Air-cooling is employed in a number of smaller motors, various manufacturers claiming special efficiency for their systems. The Knox two-

cylinder 14 to 16 H. P. motor has a patented system of air-cooling. The Lanchester (English) two-cylinder 18 H. P. motor creates a circulation of air away from the motor by two aluminum fans assisted by wind-scoops outside the car.

Horizontal double-opposed motors, either water- or air-cooled, like the Knox, form a considerable class in America. This arrangement of cylinders was patented by Daimler in 1886, and was introduced into the United States in the first Haynes-Apperson motor about 1894. This construction is used abroad in the Mors 6 H. P. motor, the Hermes 16 H. P. motor, and the Henroid (English) 10 H. P. air-cooled motor, and others.

The latest model Haynes-Apperson two-cylinder 16 to 18 H. P. motor is set crosswise the car. Cylinders with water-jackets are cast integral. Cranks are set at 180° on shaft with adjustable roller bearings. Valves are mechanically operated. Ignition is by jump-spark with battery current, and cooling is by water circulation through tubular radiator. No governing mechanism is employed other than the foot-pedal throttler.

The Stevens-Duryea 7 H. P. motor differs from the foregoing by having the exhaust-valves operated by a single cam. Throttling is performed directly on the atmospherically operated inlet valves by means of a hand-lever, controlling a rod which acts by means of wedges to control the lift of the valves. The piston stroke ($4\frac{1}{2}$ inches) is shorter than its diameter ($4\frac{3}{4}$ inches). The motor

is set with the length of the car, the transmission is by the individual clutch system.

The Ford 10 H. P. double-opposed motor (cylinder bore 4½ inches, stroke 4 inches) has all valves mechanically operated and interchangeable. Cooling is by water with pump and radiator. Lubri-

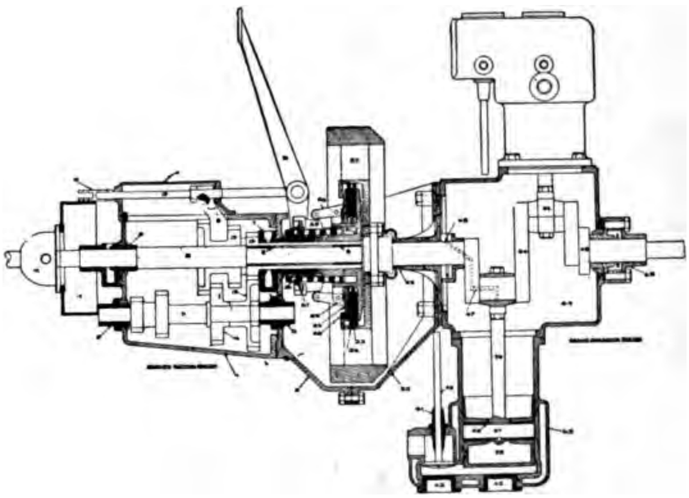


FIG. 94.—PLAN OF ST. LOUIS HORIZONTAL DOUBLE-OPPOSED MOTOR AND INTEGRAL SLIDING-GEAR TRANSMISSION.

Motor in horizontal section, transmission in vertical section.

cation is accomplished very simply by pressure from the enclosed crank-case operating through a set of six sight-feeds. Transmission is by crypto-gear. The motor is placed longitudinally under the seat of the car.

The St. Louis 18 to 22 H. P. horizontal double-opposed motor, bore and stroke each 5 inches, has

sliding-gear transmission integral with the motor proper (see Fig. 94).

The Rambler 16 H. P. and the Maxwell 16 H. P. double-opposed motors are water-cooled by thermo-siphon system.

The Lanchester double-opposed motor is of the balanced type. (See Fig. 95.) Original methods of balancing are resorted to in a number of two-cylinder motors.

The Turgan and Foy (English) 10 H. P. motor has the cylinders directly in line with each other,

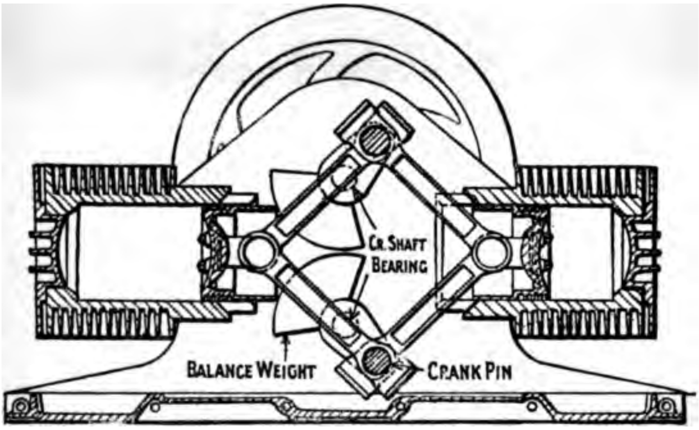


FIG. 95.—LANCHESTER AIR-COOLED, DOUBLE-OPPOSED, BALANCED MOTOR.

each working on a separate crank-shaft. Both shafts are geared to a central half-time shaft.

The Mees horizontal balanced motor consists of a single cylinder in which two pistons are driven in opposite directions by the same explosion in a central combustion chamber. Rocking beams and

connecting-rods transmit the impulses to cranks on the main shaft. (See Fig. 96.) Central combustion between two pistons is also employed in the Gobron-Brillié two-cylinder vertical motor, as

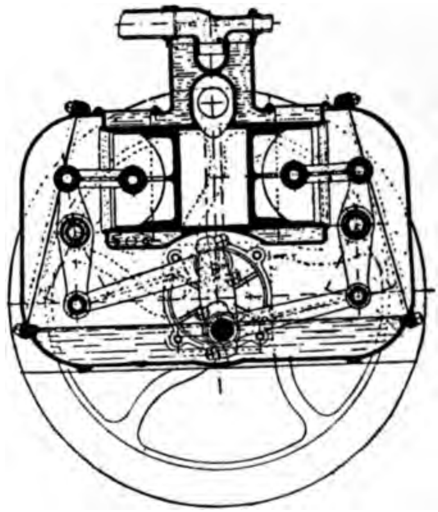


FIG. 96.—MEES HORIZONTAL, BALANCED MOTOR, WITH CENTRAL COMBUSTION CHAMBER BETWEEN THE PISTONS.

shown in Fig. 97. This motor dispenses with a carbureter.

Two-cylinder vertical motors differ little in general construction and operation from four-cylinder motors. Both cylinders with their water-jackets are usually one casting. This is not the case, however, in the de Dion-Bouton motor, where a patented cylinder-head (Fig. 98) affords means for varying the compression space. Well-known twin-cylinder vertical motors abroad are the Thorneycroft,

Simms, Benz, Decauville, Mors, Watsonia (Durkopp). In America are the Pope-Tribune, Marsh, Mitchell, Acme—rated all the way from 6 H. P. to 16 H. P.

Single vertical-cylinder motors of note are the de Dion, Peugeot, Simms, Pope-Tribune, and Pierce. Single-cylinder horizontal motors are not much employed abroad, but in this country such types as the Olds, Cadillac, Crest, Rambler, St.

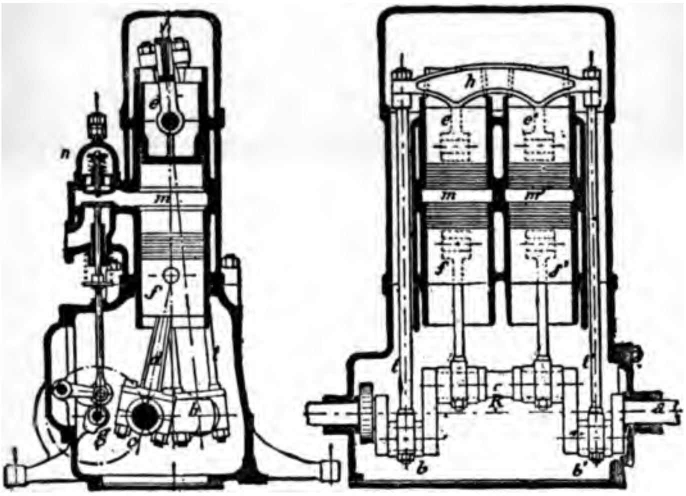


FIG. 97.—GOBRON-BRILLIÉ VERTICAL DOUBLE-OPPOSED MOTOR, WITH CENTRAL COMBUSTION CHAMBERS.

f f', pistons driving on common crank, *R*, by means of connecting-rod, *d*; *e e'*, pistons driving on cranks, *b b'*, by means of bar, *h*, and connecting-rods, *t t'*; *m m'*, central combustion chambers; *g*, exhaust cam; *n*, admission-valve.

Louis, Pierce-Racine, and Pope-Hartford, rated at from 6 H. P. to 12 H. P., are representative of the American development of the light car.

The three-cylinder vertical motors form an interesting class, represented abroad by the Panhard, the Brooke 10 H. P., and the Maudsley 25 H. P. This construction has been abandoned by the manufacturers of Pope-Toledo and Thomas motors, who were formerly very successful with it. The Thomas high-powered motor still retains the principle in an arrangement of six cylinders. Napier and Duquesne motors are also constructed of six cylinders.

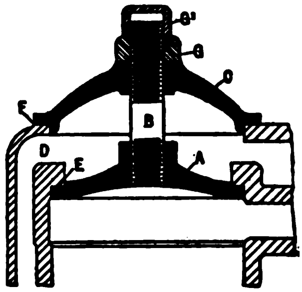


FIG. 98.—DE DION-BOUTON CYLINDER-HEAD.

A and *C*, solid concave lids of combustion chamber and water-jacket; *E* and *F*, flanges of cylinder-casting; *B*, connecting-stud tightened by nut, *G*, and lock-nut, *G'*; *D*, space for water circulation.

Three vertical cylinders with cranks working at 120° are used in the Cameron 12 to 15 H. P. air-cooled motor, the St. Louis 20 H. P. motor, and the Phelps 20 H. P. motor.

In the compound 12 to 15 H. P. motor a low-pressure cylinder, without water-jacket, is placed between the other two cylinders, its piston diameter being about three times that of the smaller cylinders. The cranks of the high-pressure cylinders are both set 180° from the low-pressure crank. The exhaust from the smaller cylinders is fed alternately into the larger one, thus giving it a power-impulse at each downward stroke; hence

the crank-shaft receives an impulse once in every half-revolution, the same as in four-cylinder motors. A gain in power of 50 per cent in propor-

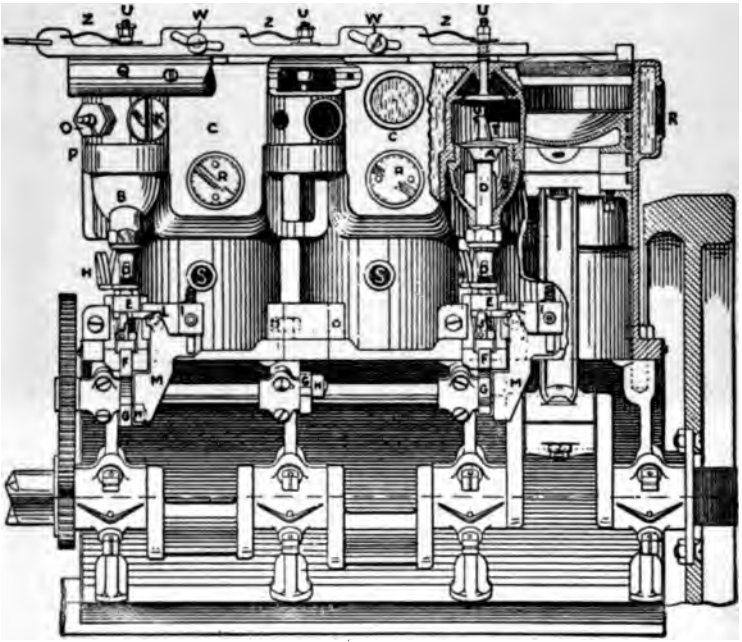


FIG. 99.—ELEVATION OF DURYEA THREE-CYLINDER MOTOR.

A, exhaust-valves; *B*, exhaust-valve seats; *D*, hollow valve-stems in which sparker-stems, *T*, oscillate; *E*, exhaust-slides; *F*, exhaust-slide rollers; *G*, exhaust-cams; *H*, spring; *L*, hammer of sparker-stem; *J*, clamp engaged to *L* by coil-spring; *N*, roller on cam, *G*, actuating lift *M*, and through it, hammer *L*, thus oscillating sparker-stem, *T*, against insulated portion of spark-plug, *O*; *U*, inlet valves; *Q*, feed-pipe; *W*, supporting screws of throttle-slide; *Z*, springs of throttle-slide.

tion to fuel consumption is claimed for this system, with the added advantage over a four-cylinder motor of reducing the operative mechanisms for

ignition, cooling, etc., by one-half. It is also claimed that by virtue of the more uniform pressure in the larger cylinder, the motor gives stronger torque on low speeds. The muffler is dispensed with, and the exhaust to atmosphere is said to be quiet and odorless at high speeds.

The first three-cylinder automobile-motor was designed in this country by Charles E. Duryea. It

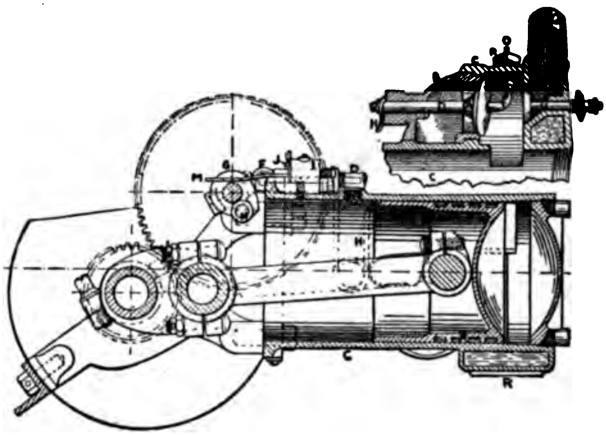


FIG. 100.—PLAN OF DURYEA THREE-CYLINDER MOTOR.

is still used in improved form on the Duryea car. The motor is inclined almost to the horizontal, which position causes the oil to drain into the crank-case, preventing flooding. The three cylinders, dimensions $4\frac{1}{2}$ by $4\frac{1}{2}$, are in one casting, with exhaust-passages between their walls. Ignition is by low-tension magneto, the make-and-break contact being operated by sparker-stems which oscillate within the hollow stems of the exhaust-

valves. The inlet valves are atmospherically operated. Only the combustion chamber is water-jacketed. (See Figs. 99 and 100.)

A three-cylinder motor of considerable interest is the Adams-Farwell, whose three horizontal cylinders revolve around a stationary crank-shaft. The cylinders have a 5-inch bore and 4½-inch

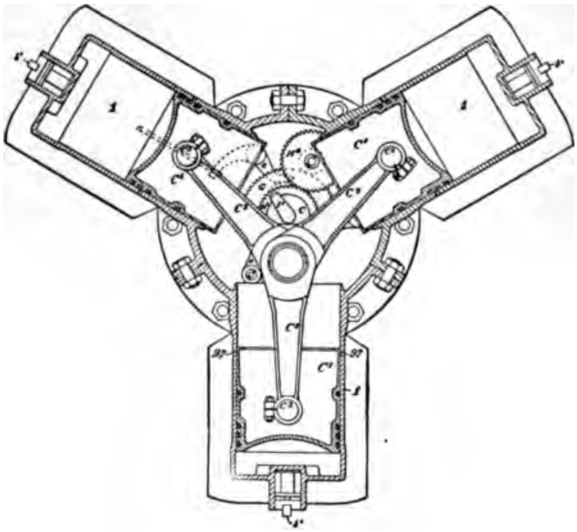


FIG. 101.—HORIZONTAL SECTION OF ADAMS-FARWELL REVOLVING THREE-CYLINDER MOTOR.

C^1, pistons; C^2, pitmans connected to single-crank wrist-pins, C^4.

stroke, and are cooled by air-circulation set up by their own revolution around the shaft. Power is transmitted by bevel-gear from the revolving crank-case. The cylinders are of the four-cycle type, the explosion occurring in each as it passes dead center. (See Figs. 101 and 102.)

Motors operating on the two-cycle principle invented by Dugald Clerk in 1880 are the Lister, the Elmore (American), and the Gobron.

The Elmore motor was first put on the road in 1900, and since that time its performances seem to justify the claims made for it. In construction

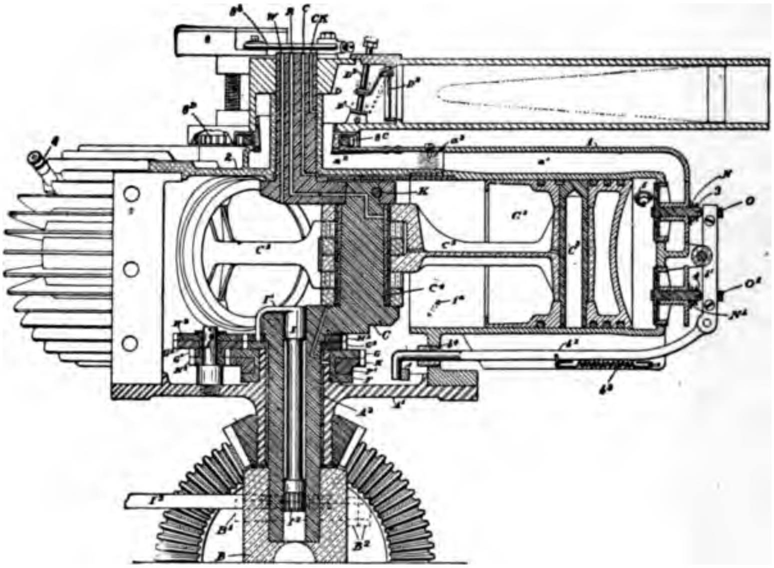


FIG. 102.—VERTICAL SECTION OF ADAMS-FARWELL REVOLVING, THREE-CYLINDER MOTOR.

it is exceedingly simple. There are two cylinders cast in one piece with the crank chamber, but with heads tapped in.

Theoretically the two-cycle motor is twice as efficient as the four-cycle type, cylinder for cylinder. In practise, leakage of the charge and dilution of the mixture by the burnt gases remaining in the

cylinder, together with the somewhat inferior compression attained in two-cycle motors, according to authorities reduces the actual gain in power to about 60 per cent. They are undoubtedly the simplest motors in construction, since there are no valves, gears, cams, springs, etc. In the Elmore motor the mixture is drawn into the air-tight crank-case through an admission-port, which is closed by the piston for about 270° of a revolution, and open when the piston is at the top of its stroke, when the gas rushes in to fill the partial vacuum created by the up-stroke. (See Fig. 103.) On the

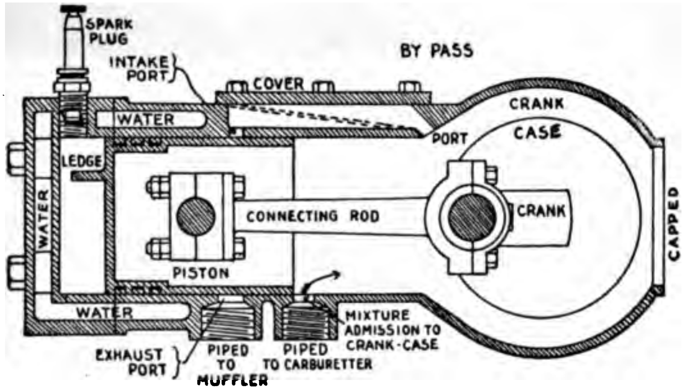


FIG. 103.—SECTION OF ELMORE TWO-CYCLE MOTOR AT END OF COMPRESSION-STROKE, SHOWING ADMISSION OCCURRING IN CRANK-CASE; COMPRESSED MIXTURE ABOUT TO BE FIRED.

return-stroke the piston closes the inlet port, partly compresses the mixture in the crank-case, and finally forces it through the by-pass and intake port into the opposite end of the cylinder. The fresh mixture forces the residue of exhaust before it,

being guided by a ledge on the piston in the direction of the arrows. (See Fig. 104.) The exhaust-port, being wider than the intake port, opens first, so that the largest part of the exhaust escapes by

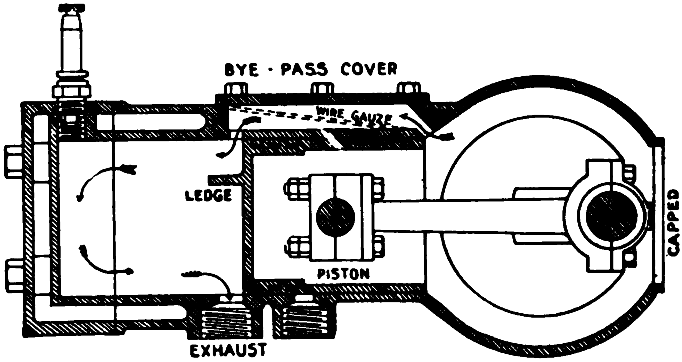


FIG. 104.—SECTION OF ELMORE TWO-CYCLE MOTOR AT END OF FIRING-STROKE; EXHAUST AND ADMISSION OF MIXTURE TO CYLINDER TAKING PLACE.

expansion before the fresh charge begins to enter. Back-firing is prevented by a wire-gauze screen in the by-pass. The up-stroke of the piston compresses the charge; it is then ignited. Lubrication is by splash system, and the oil-mist in the crank-case mixes with the charge and, it is claimed, adds to the efficiency of combustion. The fresh mixture cools the walls of the crank chamber, and a water-jacket surrounds the combustion end of the cylinder.

CHAPTER VIII

TYPES OF THE STEAM-MOTOR

ALTHOUGH at first a decided impulse was given to the automobile industry in America by the small, alternating, simple-expansion motor, with two ver-

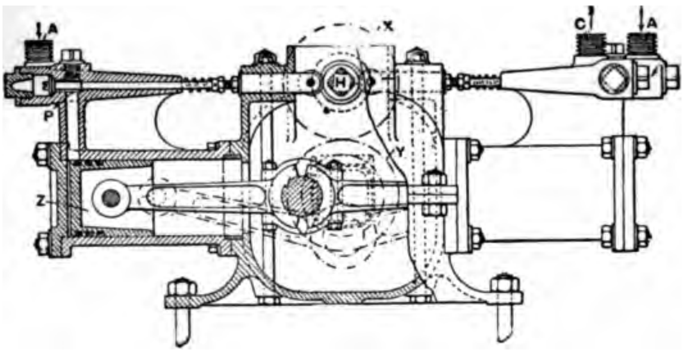


FIG. 105.—SIDE ELEVATION OF SERPOLLET MOTOR.

tical cylinders, as employed in the Locomobile, the steam-motor at present is much more prevalent abroad, especially in England.

The Gardner-Serpollet four-cylinder horizontal motor of the simple-expansion type is single-acting, i. e., steam is introduced against only one face of the piston. The construction is more nearly that of the gasoline-motor than the ordinary steam-motor, as will be seen from Figs. 105–108. The

pairs of opposed cylinders work upon common crank-pins, the two pins being at right angles to each other. The superheated steam from the "flash" boiler enters at *A* (Fig. 108), passes into

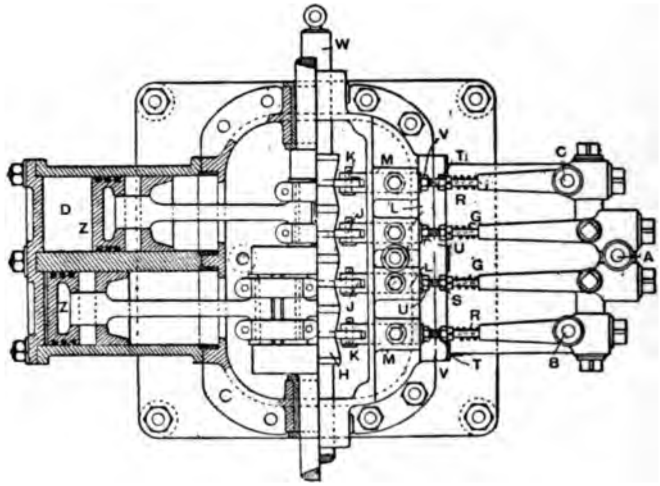


FIG. 106.—PLAN OF SERPOLLET MOTOR.

the valve-box, *E,* with admission-valves, *F,* closed by springs, *G,* and the steam-pressure. The valves are actuated by the composite cam, *H,* through rollers, *J,* and slide-rods, *L,* operating on the valve-rods *N.* The steam enters the cylinder through passage, *P,* and is driven back through the same passage, after expansion, by the return-stroke of the piston *Z*; whereupon the exhaust-valves, *Q,* are opened, allowing the steam to escape through *B* and *C.* The composite distribution-cam, *H,* is in the same vertical plane as the motor-shaft. The rollers, *J K,* bear on the depressions between two

opposite inclines, terminating in cylindrical surfaces giving the maximum admission or exhaust. The cam, *H*, is in one piece with the square shaft, *W*, which may be slid longitudinally by hand-lever or by motor-governor, altering simultaneously and equally the throw of the admission and exhaust portions of the cam. The spur-wheel, *X*, on the end of the shaft, *W*, engages with a wheel of equal diameter, *Y*, on the motor-shaft. The wheel, *X*,

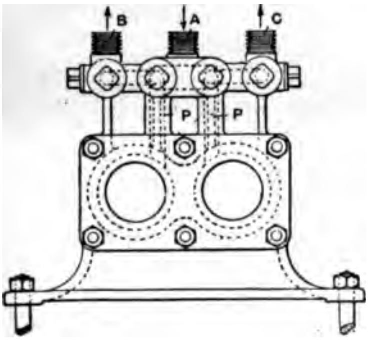


FIG. 107.—END ELEVATION OF SERPOLLET MOTOR.

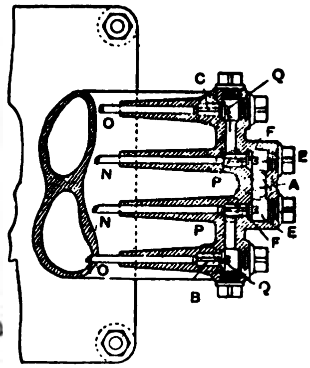


FIG. 108.—SECTIONAL PLAN OF SERPOLLET VALVE.

may be moved either forward or backward in relation to wheel, *Y*, so as to advance or retard admission and exhaust. The exhaust portions of the cam, *H*, operate through rollers, *K*, and rods, *O*, upon the exhaust-valves, *Q*, allowing them to close through action of the steam-pressure and springs, *R*, when the piston has reached the proper point in the return-stroke. By means of this composite cam-shaft it is possible to vary the cut-off, to pre-

vent admission and exhaust altogether, or to time admission so as to reverse the rotation of the crank-shaft.

The Miesse single-acting motor is similar in principle to the above, having three horizontal cylinders cast in one. The Simpson-Bodman is another single-acting motor, the three cylinders being set at 120° to each other, and acting on a common crank-shaft.

The Négre single-acting motor has the four cylinders set horizontally at right angles to each other. Six-cylinder horizontal single-acting motors have been designed for Gardner-Serpollet and Clarkson-Capel cars.

Double-acting or alternating steam-motors are merely small steam-engines constructed from materials which give a maximum of strength and lightness. The usual sliding-gear and link are employed. These small motors are generally very efficient and reliable and capable of considerable elasticity. (See Fig. 109.)

In the construction of alternating steam-motors, the preference is now for the compound or double-expansion type, in either two or three cylinders placed vertically or horizontally.

The de Dion-Bouton two-cylinder compound horizontal motor, by a special valve enables steam to be admitted directly to the larger cylinder; thus the motor may be run by simple expansion when extra effort is needed. The Lifu (English) two-cylinder horizontal compound motors may also be

run by simple expansion when desired. This construction is usual in American compound motors such as the White and Lane.

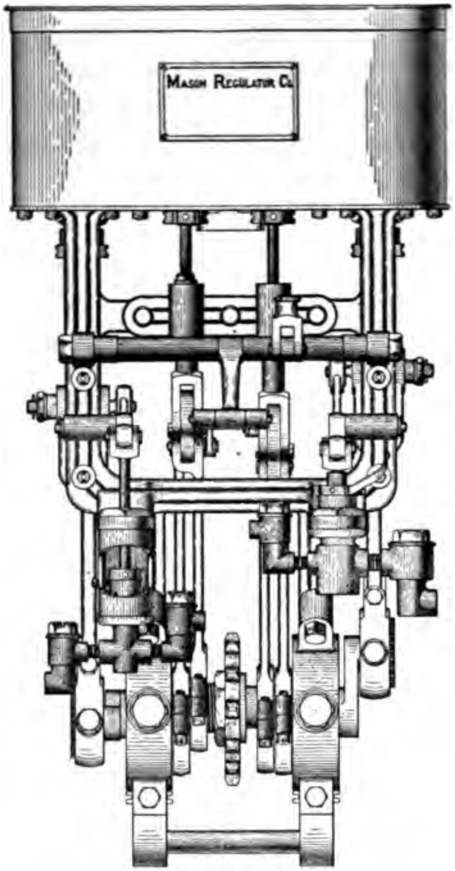


FIG. 109.—TYPE OF DOUBLE-ACTING, SIMPLE EXPANSION STEAM-MOTOR FOR AUTOMOBILES.

The Thorneycroft (English) two-cylinder compound motor uses a special radial valve-gear in-

stead of the usual link motion. Change-speed gear is also employed.

Attempts have been made to adapt to automobile use the principle of the rotary motor. An omnibus of the Cie. Générale des Automobiles in Paris was driven by an epicycloidal rotary motor which behaved in an interesting manner. The motor was constructed on the Gerard system. Two rotary motors were exhibited at the Tuileries, the Arbel-Tihon in 1898 and the de Lambilly in 1899. A perfect rotary motor for automobile use, driven either by steam or gasoline, would simplify many of the problems of automobile construction, notably that of transmission, since greater flexibility would be attainable if the rotary motion could be obtained directly by the pressure of expansive gases against a cylindrical drum keyed eccentrically to the motor-shaft. This in general is the principle of the rotary motor.

CHAPTER IX

HOW TO CHOOSE AN AUTOMOBILE

THE reader who has only glanced over the preceding pages will probably turn to this one in a state of bewilderment. It may seem like reading the catalogues of various manufacturers in the vain hope of thus deciding as to a prospective bargain, or like listening to the arguments of several salesmen, representing different makes of cars, each hoping for a purchaser's decision. The reader will be in no better case after riding around with a number of owners of different machines, however, for if he escapes being "wounded in the automobile of a friend," he will learn nothing of its disadvantages for his particular case. True, after a very brief season of this empiricism, he will have a realizing sense of the absolute perfection to be found in the "epicycloidal transmission" of the "Cartillage" machine; or perchance he will understand thoroughly that with the "Nolens" motor, compression is so positive that "you do not often have to crank her." He may think there may be more than he knows in the claims of the little "Diapason" machine, which broke the record for brake horse-power in the wonderful trip across the Appalachians.

$650. 7 H. P.

$750. 7 H. P.

$750. 8-12 H. P.

$900. 10 H. P.

$1,500. 14-16 H. P.

$1,750. 14-16 H. P. FOLDING REAR SEAT.

FIG. 110.—TYPES OF LIGHT CARS FOR TWO PASSENGERS.

Last of all, he will be fully convinced that the motor of the future will be able to make a trans-Siberian run cooled entirely by a single gear-driven palm-leaf fan.

It is in such mental states that prospective automobilists turn surreptitiously to books which will tell them exactly what to do. The wise writer of the authoritative handbook on automobiles "foreseeth the evil and hideth himself" behind both horns of the following dilemma: "If you are a billionaire, get some one of the most reputable foreign manufacturers to build you the most expensive car he can turn out. If you are not, go to an incorruptible expert of undoubted reputation, pay him a fee, and abide by his judgment." The only objection to this advice is that few billionaires read handbooks, and that the geographical distribution of incorruptible experts is so meager that by the time the neophyte has paid the fee or fees, he will have saved little or nothing as against the practise recommended to the billionaire.

The patient, therefore, when he has reached this stage and this chapter, had better sit down "with a firm purpose of amendment" to anything he has ever heard said about automobiles, and try to think what to expect. *Imprimis,* he may indulge in the pleasing reflection that "a man can travel *without a load* on level ground during eight and a half hours a day at the rate of 3.7 miles an hour, or 31¼ miles a day." No great improvement has been made in man's means of individual locomo-

A TYPE OF IMPORTED TOURING-CAR.

The Panhard (15 H. P.) equipped with side-door tonneau body and cape cart-hood.

tion since the days of the chariots of the Pharaohs till the invention of the automobile. Let us reflect for a moment upon "the disappearing horse" that has bridged over this chasm. Theoretically a horse is good once a day to draw a load of 3.6 tons one mile on the turnpike at a speed of 10 miles per hour. If you halve the speed you may double the load or the mileage, or if you halve the load you may double the speed or the mileage, but after all, there you are—your horse can draw 1,600 pounds 23 miles a day, but if he can do that he can not trot a mile in 1.08.

Now a machinery horse-power is equivalent to that of 4½ horses. A 6½ B. H. P. motor may be able during twenty-four hours to do the work of nearly 30 horses, but they will not be thirty or even three different kinds of horses. You do not expect old "Dobbin," "perfectly safe for ladies and children," to pass everything on the road, nor do you expect your blooded mare "Peggy" to go out in all weathers. Neither, therefore, must you expect to find any one automobile that will do all the wonderful things which you have many infallible proofs an automobile can do.

Thirty horses starting at the rate of one mile per hour could each exert a steady pull on your wheels of 375 pounds, or 11,250 pounds altogether. Since it takes 4.55 pounds' pull per 100 pounds of load to accelerate the speed one mile per hour per second, *ergo,* if your car weighs 1,000 pounds, in four minutes you would be going 240 miles an hour.

Stanhope with Folding Front Seat.
$1,200. 8 H. P.

Detachable Rear Entrance Tonneau.
$1,400. 20 H. P.

Side Entrance Tonneau.
$1,200. 22 H. P.

Detachable Rear Entrance Tonneau.
$950. 10 H. P.

Side Entrance Tonneau.
$1,400. 20 H. P.

Side Entrance Tonneau.
$900. 12 H. P.

Fig. 111.—Types of Light Cars for Two or Four Passengers.

Of course long before the car could attain such a speed, it would be going faster than the horses could trot, and they could no longer "work their pull," so to speak.

Your 6½ B. H. P. motor, owing to losses in transmission, can render only about 50 per cent of its power available at the road tires, exerting there a push-off of about 1,220 pounds if the wheels did not slip. As a matter of fact, they would not bite the ground hard enough to admit, in a 1,000-pound car, of a greater push-off than 375 pounds, since only about 0.6 of the weight of the car is on the driving-wheels, and only .025 of this represents the average adhesion between rubber tires and road. So that, with your 6½ B. H. P. motor and 1,000-pound car starting off at a mile an hour, you really have less available power than with one average horse, since a horse can double or triple his muscular effort and can increase it tenfold momentarily. Your mechanical horse-power is least available therefore when you most need it, viz., in starting and in accelerating your speed. You can secure better adhesion only by increasing the weight over the driving-wheel, which is practically what happens when going up-hill; but on the level this is only practicable by increasing the weight of the car.

A 2,000-pound car will give adhesion enough to admit of a 750-pound push-off, at one mile per hour, without skidding. Such a car not only renders more power available for starting, but will pick up speed more quickly, since the rate of accel-

eration of a car is directly proportional to the amount of tractive effort. According to experiments of L. M. Aspinall, an effort of 4.55 pounds per 100 pounds' weight of vehicle is necessary to accelerate the speed one mile per hour per second. On the other hand, once started, if speed and power increase in direct proportion, no more adhesion will be required for a speed of forty miles an hour than for a speed of one. The following table by Mr. Lyon Sampson illustrates this:

To develop	1	H.P.	when traveling at	1	m.p.h.	a pull of	375 lbs.	must be	exerted.
"	10	"	"	1	"	"	3,750	"	"
"	10	"	"	10	"	"	375	"	"
"	20	"	"	20	"	"	375	"	"
"	30	"	"	30	"	"	375	"	"
"	40	"	"	40	"	"	375	"	"
"	40	"	"	20	"	"	750	"	"
"	40	"	"	1	"	"	15,700	"	"

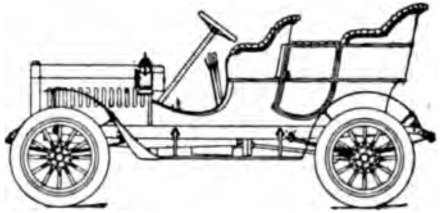
To keep a 2,000-pound car going at the rate of ten miles per hour, a push of rather less than 3 per cent of its weight is needed, the remaining power being rendered available for acceleration, provided it is not suddenly increased above the limit of adhesion, in this case 750 pounds.

Having indulged in these abstract considerations, the prospective purchaser should begin to adjust his expectations of horse-power in the same sensible way he would if buying a horse.

The man about to buy his first automobile vaguely expects too much. He will expect to "go anywhere" in it, and he will expect to go fast. Calculations of distance fall naturally in his mind into the terms of a mile a minute. If he lives in town

$1,350. 16 H. P.

$1,750. 18 H. P.



$1,700. 20 H. P.

$1,400. 16 H. P.

$1,600. 16 H. P.

$1,400. 12 H. P. REAR ENTRANCE.

FIG. 112.—TYPES OF TOURING-CAR, SIDE ENTRANCE TONNEAU FOR FOUR OR FIVE PASSENGERS.

he will expect to take trips of one hundred miles into the country and to get back the same day. If he lives in the country he will expect to go to town, or from one town to another, at a uniform rate of speed, regardless of roads, hills, or weather. In a general way a man who has never owned an automobile rather expects it to provide all the delights and utilities of a private railway train, a racing-stable, a coach-and-four, a smart span of horses, a safe family hack, a pony cart for the children, and a morning walk. He expects it to do this without any trouble, and at a very moderate expense. It is true in a sense that the automobile is a fair substitute for any of these, and is cheaper, mile for mile, speed for speed, weight for weight, when consistently so used. But the question of expense is after all the crucial one which makes it necessary to give some other advice than that to the billionaire aforesaid. As we have pointed out, the prospective automobilist is reckoning the advantages of ownership chiefly in terms of speed, and properly enough, since speed has a direct bearing on the question of utility. Some of the relations of horse-power and weight have already been pointed out, and little more need be said to convince the chooser of an automobile that speed is intimately connected with these. With a good sound horse you may average ten to twelve miles an hour. If you want to travel at the old coaching-rate of twenty miles an hour, you must have relays of fresh horses.

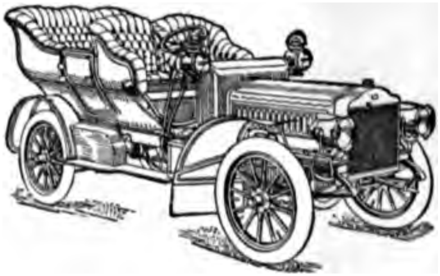
A TYPE OF FOREIGN CAR.

Mercedes (28-30 H. P.) coupé-length chassis, equipped with extension-front landaulette body.

If you live in the city, the first consideration which will appeal to you is the ability to get about conveniently, and here the electric vehicle suggests itself. It is the easiest to learn to run and more members of your family can use it. It is silent, it is swift enough to exceed the speed limit on boulevards or other clear stretches where the police are not looking. It will work along the most crowded thoroughfares more patiently and effectively than a horse. It requires less care and attention than any other form of car, and consequently its up-keep will cost less. Its radius, however, is limited to some ten or twelve miles, or to double that if you can select for your day's outing a suburban point where there is a charging station.

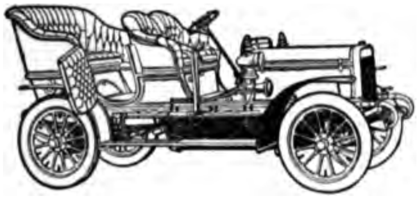
If you are not satisfied to confine the activities of your car practically to the city limits, you will begin to look favorably upon some light form of gasoline-car or steamer. Either of these will meet your town requirements fairly well, though not so well as the electromobile. The steam-motor more nearly approaches the electric in elasticity. It will therefore be easier to operate amid heavy traffic than would the gasoline-motor. It will not be so convenient in long delays and standing, and will take more time in starting. For trips into the country the steamer perhaps gives the greater radius. It is easier to find fuel and water for it in out-of-the-way places and to unearth a local mechanic who can be of service in case of breakdown. In general, the steamer will be cheaper in

$2,000. 16–20 H. P.



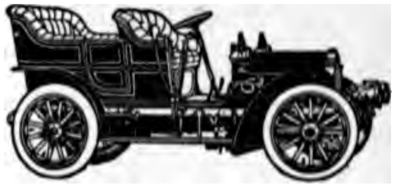
$3,000. 40 H. P.

$3,200. 24 H. P.



$3,500. 24 H. P.

$3,500. 18 H. P.



$3,700. 15–20 H. P.

FIG. 113.—TYPES OF TOURING-CAR, WITH SIDE OR REAR ENTRANCE TONNEAU.

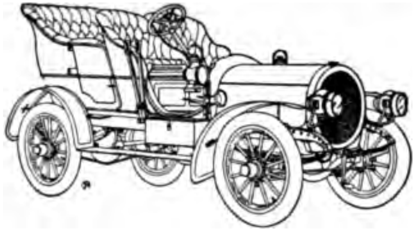
first cost and give greater average speed for the cost. It will be fully as cleanly as a gasoline-car and rather more silent. It will, however, require more care on and off the road, and will give more trouble in cold weather, and the presence of the boiler and its attachments will be a greater tax on the time and attention of the amateur who must dispense with the services of a paid driver. This disadvantage is not felt so much by the country dweller, who would find the gasoline-machine requires about as much of his personal attention, owing to isolation from the skilled repair-shop. But we are considering the case of the city man who wishes to use his car chiefly in town and still take trips into the country. The trouble with him usually is that he expects too much of his light car. If he gets a light gasoline-car with two speeds forward, he finds the low speed meets his requirements fairly well, but beyond this he has no means of not exceeding the speed-limit, and his patience will be taxed many times by the absence of any intermediate speed. Here the steamer, with its absence of speed-gear and its greater flexibility, will appeal to him. Again, it will not be long before he begins to take trips into the country, and here, lured on by the exhilarating discovery of the speed he can really get out of his light car, he will go bouncing along over country roads until he has shaken his frail machine out of commission. If he is going to do this, the steam-car will again give him less vibration and somewhat longer service.

If he has actually gone through a year's experience of a light car in town and country, and reflects upon the various things it has done and the other things he can not do with it, he will probably wonder if he would not have done better to purchase a heavy, high-powered touring-car at the start. True, this would not be quite so convenient for working slowly along city streets where the impatient motor, even when throttled down, is liable to fret and overheat itself. But there would be a speed for every conceivable condition of running, and he would now be willing to sacrifice something in the convenience of street travel to be able to obtain the freedom of the country road. He could take the whole family along without being crowded or without getting stuck on a hill or a bad road. He would have fittings affording suitable protection in all weathers, and he now thinks it would not be so hard to manage the machine himself.

But he is liable to forget that a year ago this was not the case, and his year's experience has probably cost him less than if he had experimented with a more expensive car. If he were our friend the billionaire, who had from the start a trained chauffeur to run and teach him how to run the big machine, he would have been wise to make choice of a forty-horse tonneau, and thus make possible the widest range of automobile activity.

But the man of average means, who is to be his own driver, will, during his first year, get more

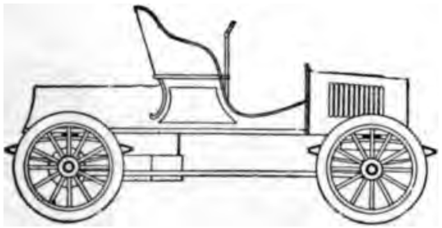
$3,500. 28 H. P.



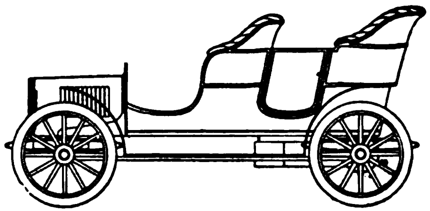
$2,500. 23–30 H. P.

$4,000. 35–40 H.P.

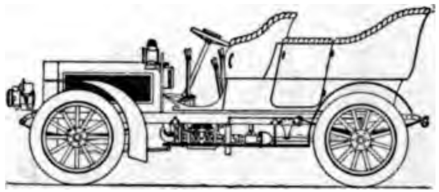
Fig. 114.—Types of Side Entrance Touring-Car.



$850. 10 H. P.



$1,000. 10 H. P.



$5,000. 20 H. P.

Fig. 115.—Types of Steam-Car.

satisfaction out of a well-built light car, even though he misuse it. It is the fruits of misuse which have led some to refer to the small car as "a license to spend twice what you pay for it." But with proper care this can be proved a fallacy. It will require you to restrain your first enthusiasm somewhat. You will have to remember that your car is not a racer nor a touring-car. When you speed it you must be careful about the road, and when you try for long distance it must not be too long. Remember that the car is essentially designed for only two passengers, and even though it is fitted with a detachable tonneau, when you use this do not try to go as fast or as far as when carrying less load. You will find the extra seat a convenience with scarcely any drawbacks for town travel, but when attempting distance you will have to consider carefully road, grades, and weather. You may have many a day's outing of one hundred miles, if you plan them very much as the expert bicyclist would, and do not forget that if you would not toil neither must you "spin" too much. In the mean time you will be learning a good deal in a practical way about automobiling, and be able to take care of your car yourself or with the assistance of a hired man, falling back upon the machinist for difficult repairs, and thus eliminating the chauffeur from your first year.

It may be that you are too impatient in disposition to be able to live up to the foregoing advice and go slow. It is then incumbent upon you to

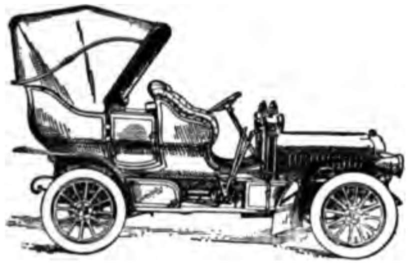
decide how fast you will go. Not how fast for a few hours, to be followed by several hours of fretful delay, for this would obviously reduce your rate of travel on many vexatious occasions. But, having decided how many passengers on the average you desire to carry, and how far and over what kind of roads, you must make up your mind how fast, day in and day out, you want to go. When we get much below the billionaire class this question is usually decided for the purchaser by the question of how fast he wants to go in spending money, for speed and price vary in practically direct proportion; which means that when you make up your mind how much you can do without in the way of expensive body-fittings, the sum you have left will determine how powerful a car you can buy. A glance at the following tabulation of the exhibits at the New York Automobile Show of 1905 will convince you of this:

AMERICAN CARS EXHIBITED AT THE NEW YORK AUTOMOBILE SHOW OF 1905

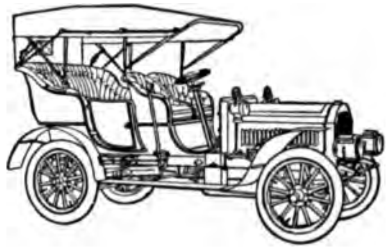
Grouped according to price, horse-power, and weight

Cost	H. P.	H. P. Average	Weight in Lbs.	No. of Cars Exhibited
Under $500......	4	4	500–550	2
$600 to $650......	6–10	7	750–1,000	6
$700 to $950......	7–12	10	800–1,500	19
$1,000 to $1,750...	8–22	12–18	1,000–2,000	57
$1,800 to $2,800...	15–30	16–25	1,600–2,600	31
$3,000 to $4,000...	15–50	25–50	2,100–2,900	29
$5,000 to $7,500...	24–60	40	2,300–3,000	11

Taking six leading makers of foreign automobiles, we find the same relation holds good. Cars



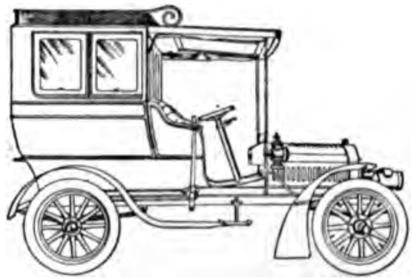
$3,500. 50 H. P.



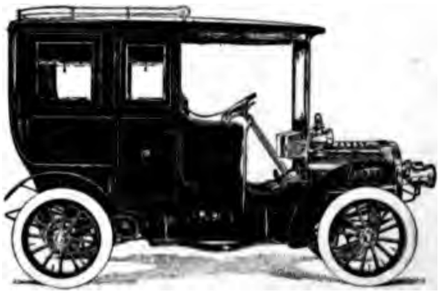
$4,000. 20–32 H. P.

$6,000. 60 H. P.

SURREY WITH TOP.
$1,500. 18 H. P.



OPERA BUS.
$4,000. 28–32 H. P.



LIMOUSINE.
$3,000. 20 H. P.

FIG. 116.—TYPES OF COVERED CARS.

of 10 to 15 H. P. cost from $3,000 to $7,000, of 20 to 25 H. P. cost from $5,000 to $9,000, of 30 to 50 H. P. cost from $6,500 to $12,000. If you want further conviction, study some of the lists in the automobile periodicals, where the cars of the year are described in detail, and after deducting extras for different styles of bodies and accessories, tabulate them for yourself according to price and horsepower. Then in the light of what is said in the early part of this chapter, figure out the load you have got to carry and you will be able to tell pretty nearly how fast you can carry it. It is true that the statements of horse-power written out by makers are not the most reliable index of the actual power of the car. A better method is to make your own calculations, using the formula at the end of Chapter II, or to compare the cars on the basis of piston displacement, as suggested later in this chapter. But even taking manufacturers' ratings at their face value, you will be surprised to find how much your purse will narrow your range of choice.

The prospective purchaser upon whom this attempt to show him what not to expect has been successful, may now feel himself "beaten to a standstill." He may, upon examining his exchequer, wisely conclude to get his first experience of auto-locomotion out of a motor-bicycle or perhaps a small tri-wheeler. Unfortunately for him, the latter vehicle is scarcely known here, being much more popular and better made in England, where at an initial cost of $300 to $500, and with

far less up-keep expense than a light car of the same price, these "tri-cars" are opening the country roads to a class most in need of the benefits of automobiling.

But for the man of less limited means, the problem is yet only half indicated. He must know something also of what to expect and even demand in making his choice, and here, as soon as he has decided how much he can spend, he is confronted by a multiplicity of makers, all ready to give him the most for his money. The test of the road is, of course, the crucial one, and likewise the one that it is impossible to employ so as to make it exclusive till one has purchased the car, when it is often exclusive enough. If, by some inscrutable process, however, you have settled on some one car, you should insist on the most complete road demonstration possible under as nearly the conditions of probable use as you can contrive. It were well if these include a hundred-mile run on an "American road," during which you will have abundant opportunity to note the action of the machinery. Things may happen to a new car, such as the working loose of some part, which though rather serious in effect on the trip, do not denote any inefficiency or inherent fault of construction. You should get a good idea, however, of how silent the motor can be run at highest efficiency, whether it tends to overheat, and how the car takes various gradients.

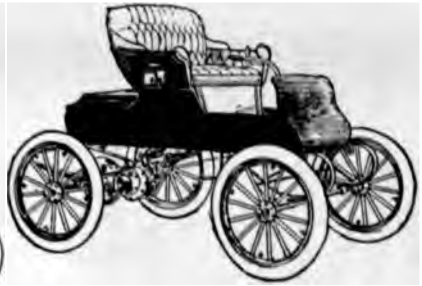
Grades are calculated in three ways: (1) by the angle which the plane on which you are travel-

ing makes with the horizontal, the perpendicular being, of course, 90°; (2) by the rise in feet per mile actually traveled; (3) by the percentage of rise to the horizontal distance traveled. Thus, if you have actually traveled a mile and are 264 feet higher than when you started, you have been rising one foot for every twenty of horizontal advance, or you have been going up a 5 per cent grade. A grade of 30° is nearly a rise of one in sixty, or 60 per cent.

One of the keenest pleasures in possessing a car is being able to annihilate a hill or "eat it up," and you will naturally want to get as much of this as you can for your money. Since a 5 per cent hill more than doubles the necessary draft at eight miles per hour, it is wise to ascertain during your road-test how steep is the grade on which you are liable to get stuck. A grade-indicator is a useful instrument that may well be taken along on your trial trip, but in its absence, you will have to do the best you can by noting the point at which your line of vision strikes the ground when looking straight ahead, and then trying to estimate how many feet distant the point is. When you think you have it, divide it by, say, 6 (your height from the ground), and you will get a rough idea of how steep is the particular hill you are ascending. In the absence of any road-test, it will be useful to estimate the relative hill-climbing abilities of different cars by dividing the cubic inches of piston displacement by the weight of the car in pounds

Runabout. $900. 3 H. P.

Coupe. $1,450. 3 H. P.



Runabout. $1,900. 3 H. P.

Stanhope. $1,500. 3 H. P.

Stanhope.
$1,400. 3 H. P.

Depot Wagon. $2,250. 2-3 H. P.

Fig. 117.—Types of Electric Cars.

divided by one hundred, as suggested by Mr. Albert L. Clough in a recent number of the Horseless Age. Cars giving ten "cubic inches of piston displacement per hundredweight" will not be very good hill-climbers, while those giving eighteen or more will be quite able, says Mr. Clough, adding that transmission-efficiency will influence this comparison somewhat. The piston displacement in cubic inches may be found "by multiplying together the number of cylinders, the square of the bore in inches, the stroke in inches, and the constant .7854," and, as Mr. Clough points out, this is also more ready and reliable data for comparing the powers of various motors than are the published statements of B. H. P. by manufacturers.

Whatever the power of the car you decide you can afford, you will do well to select the simplest and most accessible machine. Your very inexperience will help some here as a basis of comparison for how quickly the various mechanisms can be shown up and clearly explained to you. At the same time ignorance may mislead you into a hasty enthusiasm for simplicity obtained at the expense of efficiency. A study of the essential elements of automobile construction, outlined in preceding chapters, will help somewhat to recognize "freak" devices and impractical mechanisms. The "incorruptible expert" heretofore mentioned would help more if he could be found. As a substitute for him, intelligent conferences with the repair-shop man may be recommended. You will have to make his

acquaintance, sooner or later, and if you are fortunate enough to live in a city where you can wander about these shops and engage several such men in conversation upon the merits and defects of specific cars, you will gather some valuable information. The repair-man can tell you (and will tell you, if you give him a cigar and treat him as a man and brother) which cars are oftenest in trouble. He can tell you how easy or how hard it is to get at certain motors, and how certain mechanisms that appear to be "marvels of mechanical ingenuity" are always requiring to be tinkered up. Moreover, he can tell you what things are made of. If a certain car has a cast-iron fly-wheel he will know it. And you had better know it. For you will be safer with a lighted cigar over an open keg of gunpowder than on an automobile seat under which a cast-iron fly-wheel is making 800 to 1,000 revolutions per minute. A very large proportion of the fatal automobile accidents have been due to bursting fly-wheels.

The question of materials is one that you had better discuss long and carefully with the repair-man, if he appears to know his business. Unfortunately, foreign constructors are considerably ahead of us in suiting the material of the car to the work it is to do and to the particular kind of strain or shock it must endure. For instance, the tensile strength of a special nickel steel used by one manufacturer is 107,000 pounds per square inch, while that of fifty-point carbon steel is 110,-

VII

TYPE OF FOREIGN TOURING-CAR.

The Mercedes side-entrance tonneau (40 H. P.).

000 pounds. But the average elastic limit of the former is 99,800 pounds, that of the latter being only 65,000. It will be readily understood from the tabulated results of various notched-bar tests that the tensile strength is of no use beyond the limit of elasticity, since the factor of safety depends upon resistance to shock. The metal that will snap at the first blow obviously affords a lower factor than the one which will merely bend, or break only after due notice. Mr. J. S. Critchley, in a paper discussed by a recent meeting of experts in England, said that steel manufacturers in that country, while as able as those elsewhere, "did not care for small orders, and would not, as a rule, apply themselves to working out problems which might only result in small immediate orders." The same situation exists in this country, our manufacturers refusing to bother with what they call "freak steel." It is easy for American builders to ascertain the practise of French and German contemporaries, but the difficulty of securing at home proper materials deters the majority from adopting the most advanced methods. Here lies the real superiority of the foreign car, wherein by the use of special materials constructors are able to reduce the weight about one-third and still secure a greater factor of safety than is found in a heavier car built from ordinary metal.

Some American makers are enterprising enough to import the best raw materials, or to have special parts manufactured abroad. Others are con-

tent to secure strength by putting in a larger quantity of domestic metals. Some, it is to be regretted, build cars only to sell, whose natural life is short, and whose margin of safety is in many instances left more or less to luck.

The long car, necessitated by present popularity of the side entrance, constructed in the best manner with relatively long wheel-base, costs in the neighborhood of $10,000. An expert designer gives his opinion that in ten years' time the same car will be turned out for $500. The cost of material is relatively small, and the cost of labor large. But the greatest impediment to cheapness is the present cost of doing business. The sale for the standard car is too limited to admit of its being sold cheaply. As soon as the public decides that it wants many cars and does not want "cheap" ones, competition will bring the price within the reach of the every-day automobilist.

But when the chooser has accomplished the Herculean task of settling upon his first cost, he is then only at one end of his troubles. He must take into account "being" as well as "becoming" an automobilist, and here the evidence is again in favor of the small car for the beginner. In the case of the large car the necessary, and not entirely harmless, chauffeur is the largest item in running expenses. From the up-keep of the light car this is eliminated entirely, and even though the up-keep of such a car should prove greater in proportion to its cost than that of the larger machine,

the actual annual expenditure will be less for the former.

Various computations of up-keep have been made, based on actual experience of users. The following by Mr. H. L. Towle are fairly typical and illustrate the point just made:

TABLE I

Nine-hundred-dollar car used 3,000 miles per year, and sold at end of third year for $500.

Interest at 4 per cent	$36.00
Depreciation	133.00
Tires at 2½ cents per mile	75.00
Repairs and renewals	67.50
Gasoline	30.00
Washing	25.00
Oil supplies and batteries	15.00
Stable	20.00
Insurance (fire)	20.00
	$421.50

TABLE II

Thirty-five-hundred-dollar American touring-car, 20–24 horse-power, driven 8,000 miles per year, and sold for $2,000 at the end of three years.

Interest at 4 per cent	$140.00
Depreciation	500.00
Tires at 5 cents per mile	400.00
Repairs and renewals	93.33
Gasoline	106.67
Garage	300.00
Chauffeur	900.00
Oil and supplies	30.00
Batteries	15.00
Insurance (fire)	60.00
Annual overhaul	100.00
	$2,645.00

TABLE III

Imported touring-car, 20-24 horse-power, first cost $7,500, driven 8,000 miles per year, and sold for $4,500 at end of three years.

Interest at 4 per cent	$300.00
Depreciation	1,000.00
Tires at 5 cents per mile	400.00
Repairs and renewals	150.00
Gasoline	160.67
Garage	300.00
Chauffeur	900.00
Oil and supplies	30.00
Batteries	15.00
Insurance (fire)	100.00
Annual overhaul	125.00
	$3,480.67

It is clear that even though the purchaser may be able to get a good second-hand large car for the price of a new light car, he will still be better off on the score of up-keep with the latter machine. Mr. Towle endeavors to show in the following tables that between the new and a second-hand car *of the same class,* the latter is cheaper, provided you can get your friend the repair-man or the expert to recommend it as sound.

It is hardly possible to exercise too much caution, however, in the purchase of a second-hand machine. But if a second-hand car is pronounced by some competent person to be free from faults and has no other drawbacks than those necessarily arising from ordinary wear, there is at least the advantage that the car has been tried on the road and the purchaser may start out with better knowledge of its capabilities than in the case of a new car.

TABLE I

Estimated average cost per year of $1,000 car for first three years, mileage per year, 4,000.

For Average User. Total life, 28,000 miles. Depreciation, $\frac{3}{4}$ in 3 years.		*For Skilled User.* Total life, 36,000 miles. Depreciation, $\frac{3}{5}$ in 3 years.	
Interest	$ 50	Interest	$ 50
Depreciation	250	Depreciation	200
Repairs	90	Repairs	50
Tires	120	Tires	60
Gasoline	40	Gasoline	40
Oil and supplies	10	Oil and supplies	10
Batteries	10	Batteries	10
Stable	20	Stable	20
Insurance (fire)	25	Insurance (fire)	25
	$615		$465
For 4,000 miles, 15.4 cents per mile.		For 4,000 miles, 11.6 cents per mile.	

TABLE II

Estimated average cost per year of $1,000 car, bought at second hand for $300, with a remaining life of 16,000 miles, and for $500, with a remaining life of 24,000 miles, respectively. Mileage per year, 4,000.

For Average User. Remaining life, 4 years.		*For Skilled User.* Remaining life, 6 years.	
Interest	$ 15	Interest	$ 25
Depreciation	75	Depreciation	85
Repairs and renewals	125	Repairs and renewals	100
Tires	120	Tires	60
Gasoline	40	Gasoline	40
Oil and supplies	10	Oil and supplies	10
Batteries	10	Batteries	10
Stable	20	Stable	20
Insurance (fire)	10	Insurance (fire)	15
	$425		$365
For 4,000 miles, 10.6 cents per mile.		For 4,000 miles, 9.1 cents per mile.	

AMERICAN GASOLINE CARS OF 1905.

WITH SPECIFICATIONS, TABULATED IN ORDER OF PRICE.

KEY TO TABLE.

MOTOR.—Position of cylinders indicated by V., vertical; H., horizontal; I., inclined.
IGNITION.—J. S., jump-spark, with B., battery, D., dynamo, M., magneto; L. T. M., low-tension magneto.
COOLING.—A., air; W., water.
LUBRICATION.—A., automatic; S., splash; F. F., force-feed; S. F., sight-feed; G., gravity.
TRANSMISSION.—Sp., special; P., planetary; S. G., sliding-gear; I. C., individual clutch; F., friction.
SPEEDS.—The number indicates forward speeds; R., unless preceded by a number, *one*, reverse speed; D. indicates direct drive on top speed.
DRIVE.—S., shaft; C., chain; F., friction; G., gear.
STEERING.—W., wheel; L., lever.
FRAME.—T., tubular; A. I., angle iron; A. S., angle steel; A. W., armored wood; P. S., pressed channel steel; B. W., bent wood.
BODY.—R., runabout; B., buckboard; T., tonneau; D. T., detachable tonneau; S., stanhope; D. S., detachable stanhope; P., phaeton; Br., brougham; L., limousine; Lan., landaulette; V., victoria; O., opera 'bus.
ENTRANCE.—S., side; F., front; R., rear.

NAME.	MOTOR.				Ignition.	Cooling.	Lubrication.	TRANSMISSION.			Brakes.	Steering.	WHEELS.		FRAME.	BODY.			Weight.	Price.
	No. of cylinders.	Bore & Stroke.	R. P. M.	B. H. P.				Kind.	Speeds.	Drive.			Base.	Tires.		Kind.	Entrance.	Seats.		
La Petite Model A	2	2½ × 3	...	4	J. S. B.	..	A.	Sp.	2 & R.	S.	..	W.	60	2½ × 28	....	R.	S.	2	350	$375
Orient Buckboard	1 V.	3¾ × 4½	...	4	J. S.	A.	S.	P.	....	G.	..	L.	80	2½ × 26	T.	B.	S.	2	500	375
Watrous Model C	2 V.	4 × 4½	...	12	J. S.	A.	S.	P.	....	C.	..	W.	80	2 ×	A. I.	R.	S.	2	650	400
Orient Surrey	1 V.	3½ × 4¼	...	4	J. S.	A.	S.	P.	....	S.	..	L.	80	2½ × 26	T.	B.	S.	4	550	425
Orient Runabout	1 V.	3½ × 4½	...	4	J. S.	A.	S.	P.	....	S.	..	L.	80	2½ × 26	T.	R.	S.	2	...	475
Monarch Runabout	1 H.	4½ × 5½	...	7	J. S.	A.	S. F.	P.	....	C.	..	..	68	2½ × 28	A. I.	R.	S.	2	900	500
Pope-Tribune Model 2	1 V.	4½ × 4	1200	6	J. S. B.	W.	S. F.	S. G.	2 & R. D.	S.	2	W.	65	2½ × 28	A. S.	R.	S.	2	750	500

Gale Runabout	1 H.	5 × 6	...	8	J. S. B.	..	....	P.	....	C.	..	W.	..	3 × 28	A. S.	R	S.	2	1150	**500**
Watrous Model B......	2 V.	4 × 4½	...	12	J. S.	A.	S.	P.	....	C.	..	W.	85	2 × —	A. I.	D.T.	S.	4	1000	**500**
Orient Tonneau......	1 V.	3½ × 4¼	...	4	J. S.	A.	S.	P.	....	G.	..	L.	80	2½ × 26	T.	T.	R.	4	...	**525**
Overland Model 15.....	2 V.	3¼ × 3¼	...	7	J. S.	..	S.	P.	....	C.	..	L.	72	2½ × 28	A. W.	R.	S.	2	900	**600**
Covert Type A.	1 V.	4 × 4½	...	6½	J. S.	W.	S.	S. G.	2 & R. D.	S.	2	W.	72	2½ × 28	A. S.	R.	S.	2	740	**650**
Holsman No. 3..........	2 H.	....	...	10	J. S.	A.	F. F.	Rope	....	S.	..	L.	66	1½—	T.&A.I.	R.	S.	2	750	**650**
Jackson Model A......	1 H.	5 × 6	...	7	J. S.	..	S. F.	P.	....	C.	..	W.	72	3 × 28	A. S.	R.	S.	2	1025	**650**
Motor-car Model A......	2 V.	3½ × 4	...	6½	J. S.	A.	S. F.	P.	....	C.	..	W.	75	2½ × 28	A. W.	R.	S.	2	700	**650**
Northern.......	1 H.	4¼ × 6	800	7	J. S. B.	W.	S. F.	P.	2 & R.	C.	1	L.	70	3 × 28	A. S.	R.	S.	2	1000	**650**
Oldsmobile	1 H.	5 × 6	...	7	J. S.	W.	....	P.	2 & R.	C.	..	L.	66	3 × 28	A. S.	R.	S.	2	...	**650**
Reo	1 H.	4½ × 6	...	7½	J. S.	..	S.	P.	....	C.	..	W.	76	2¾ × —	A. I.	R.	S.	2	900	**650**
Kunz...........	1 H.	4¾ × 7	...	8	....	A.	....	Sp.	3 & R.	..	..	L.	72	3 × 30	A. S.	R.	S.	2	1050	**675**
Motor-car Model B......	2 V.	3½ × 4	...	7½	J. S.	W.	S. F.	P.	....	C.	..	W.	75	2½ × 28	A. W.	R.	S.	2	750	**700**
Marsh Runabout....	2 V.	4 × 4	...	10	J. S.	..	F. F.	P.	2 & R.	C.	..	W.	80	2½ × 28	A. W.	R.	S.	2	800	**750**
Maxwell Model L......	2 H.	4 × 4	1500	8–12	J. S.	W.	F. F.	P.	2 & R.	S.	1	W.	72	3 × 28	A. W.	R.	S.	2	1000	**750**
Glide Style A..	1 H.	5 × 6	...	8	J. S.	..	S.	P.	....	C.	..	..	74	3 × 28	A. W.	R.	S.	2	...	**750**
Mitchell........	2 V.	4 × 4½	...	9	J. S.	A. or W.	F. F.	S. G.	3	C.	..	W.	76	3 × 28	P. S.	R.	S.	2	1000	**750**
Rambler Model G......	1 H.	5 × 6	...	8	J. S.	W.	G.	P.	2 & R.	C.	..	W.	81	3 × 28	A. S.	R.	S.	2	1400	**750**
Pierce-Racine Model A1.....	1 V.	....	...	8	J. S. B.	W.	S.	P.	....	C.	..	W.	76	3 × 28	A. S.	R.	S.	2	1150	**750**
Oldsmobile	1 H.	5 × 6	...	7	J. S.	W.	F. F.	P.	2 & R.	C.	..	W.	76	3 × 28	A. S.	R.	S.	2	...	**750**
Cadillac Model E......	1 H.	5 × 5	...	10	J. S.	W.	S. F.	P.	2 & R.	C.	..	W.	74	3 × 28	P. S.	R.	S.	2	1100	**750**
Overland Model 17.....	2 V.	5¼ × 4	...	9	J. S.	..	S.	P.	....	S.	..	W.	78	2½ × 28	P. S.	R.	S.	2	1000	**750**
Queen Model B......	2 H.	4¼ × 4¼	...	12	J. S.	..	G.&S.	P.	....	G.	..	W.	73	3½ × 28	A. S.	R.	S.	2	...	**775**
Holsman.......	2 H.	....	...	10	....	A.	F. F.	Rope	....	S.	..	L.	66	1½ ×	T.&A.I.	S.	S.	4	900	**800**
Glide Style A..	1 H.	5 × 6	...	8	J. S.	..	S.	P.	....	G.	..	..	74	3 × 28	A. W.	D.T.	R.	4	1400	**850**
Cadillac Model B......	1 H.	5 × 5	...	10	J. S.	W.	S. F.	P.	2 & R.	C.	..	W.	76	3 × 30	P. S.	R.	S.	2	1500	**850**

NAME.	Motor.				Ignition.	Cooling.	Lubrication.	Transmission.			Brakes.	Steering.	Wheels.		Frame.	Body.			Weight.	Price.
	No. of cylinders.	Bore & Stroke.	R. P. M.	B. H. P.				Kind.	Speeds.	Drive.			Base.	Tires.		Kind.	Entrance.	Seats.		
Rambler Model H......	1 H.	5 × 6	...	8	J. S.	W.	G.	P.	3 & R.	C.	..	W.	81	3×28	A. S.	D. T.	R.	4	1400	$850
Taunton........	1 V.	....	...	7	....	..	....	P.	3 & R.	G.	..	L.	68	3×28	A. I.	R.	S.	2	1100	850
Motor-car Model C......	2 V.	4½ × 4	...	10	J. S.	W.	S.F.& F.	P.	....	C.	..	W.	78	3×30	A. W.	R.	S.	2	800	850
Queen Model 3.......	2 H.	4½ × 4½	...	12	J. S.	..	S.	P.	....	C.	..	W.	73	3½×28	A. S.	D. T.	R.	4	...	875
Auto-car Type X.......	2 H.	3¾ × 4	...	10	J. S. B.	W.	S.	S. G.	3 & R.	S.	2	L.	70	3×28	A. W.	R.	S.	2	1200	900
Crest-mobile "D"..	1 V.	....	...	8	....	A.	....	Sp.	3	S.	..	..	76	....	T.	D. T.	R.	4	1000	900
Pope-Tribune Model 4.......	2 V.	4½ × 4½	850	12	J. S. B.	W.	S.F.& S.	I. C.	3 & R.	S.	2	W.	82	3½×30	A. S.	T.	S.	4	1500	900
Wilson Model E......	1 V.	4½ × 4½	...	8	J. S.	..	A.	Sp.	....	..	..	W.	78	3×28	A. W.	D. S.	S.	2	1150	900
Union Model E	2 H.	6 × 4	...	12	J. S.	..	S. F.	F.	....	F.	..	W.	81	3½—	A. S.	R.	S.	2	1700	925
Queen Model C	2 H.	5 × 5	...	16	J. S.	..	....	P.	....	C.	..	W.	80	×30	A. S.	T.	S.	4	...	950
Oldsmobile....	1 H.	5½ × 6	...	10	J. S.	W.	F. F.	P.	2 & R.	C.	..	W.	83	3½×30	A. S.	T.	R.	4	...	950
Ford Model C..	2 H.	4½ × 4	...	10	J. S.	W.	S. F.	P.	....	C.	2	W.	78	3×28	A. I.	D. T.	R.	4	1300	950
Mahoning......	1 H.	5 × 6½	...	9	J. S.	A.	F. F.	P.	....	C.	..	..	82	3×36	P. S.	T.	S.	4	1250	950
Cadillac Model F......	1 H.	5 × 5	...	10	J. S.	W.	S. F.	P.	....	C.	..	W.	76	3½×30	P. S.	T.	S.	4	1400	950
Acme Type X..	2 V.	4 × 5	...	16	J. S.	..	A.	S. G.	3 & R.	S.	..	W.	78½	3×30	A. W.	R.	S.	2	1175	1,000
Moline Model O	2 H.	4½ × 4½	...	12	J. S.	..	A.	P.	....	C.	..	W.	86	3½—	A. S.	T.	S.	4	1400	1,000
Pope-Hartford Model B......	1 H.	5½ × 6	900	10	J. S. B.	W.	S.-S. F.	S. G.	2 & R.	C.	1	W.	78	3½×30	A. S.	T.	R.	4	...	1,000
Queen Model E......	2 H.	5 × 5	...	16	J. S.	..	...	P.	....	C.	..	W.	84	×30	A. S.	T.	S.	4	...	1,000
Union Model 2D.....	2 H.	5 × 4	...	12	J. S.	..	A.	F.	....	F.	..	W.	81	3½×	A. S.	T.	S.	4	1700	1,000
Buckmobile...	2	4 5/16 × 5	...	15	....	..	S.	P.	2 & R.	C.	..	W.	83	3×30	....	D. T.	S.	4	1500	1,050
Cameron Model L......	3 V.	3¾ × 3¼	...	12-15	J. S.	A.	F. F. & S.	S.-G.	....	..	1	W.	90	3×28	....	R. or T.	S.	4 or 2	1150	1,050

Yale Model G..	2 H.	4½ × 4½	...	14–16	J. S.	W.	F. F.	P.	2 & R.	C.	2	..	85	3½ × 30	A. S. & W.	T.	S.	4	1400	1,100
Model Style "C"....	2 H.	4½ × 5	...	12	J. S.	..	F. F.	S. G.	4	C.	..	W.	86	3 × 30	A. S.	T.	R.	4	1200	1,100
Michigan Model D......	2 H.	4¼ × 5	...	....	J. S.	..	F. F.	P.	2 & R.	C.	2	W.	80	3½ × 30	A. S.	D. T.	R.	4	1700	1,100
Glide Style D..	2 H.	4⅜ × 4	...	14	J. S.	..	A.	P.	....	C.	..	W.	80	3½ × 28	A. W.	T.	S.	4	1450	1,125
Buffum Model F......	4 V.	4 × 4	...	12	J. S.	..	S. F.	S. G.	2 & R.	S.	..	W.	86	3 × 32	A. S.	R.	S.	2	1000	1,200
Pierce Stanhope.....	1 V.	3$\frac{11}{16}$ × 3$\frac{5}{16}$	1800	8	J. S. B.	..	S.	P.	2 & R.	S.	1	..	70	3 × 30	T.	S.	S.	2 or 4	1250	1,200
E. H. V. Compound Model 4½......	3 V.	(1) 4 × 7½ (2) 4 × 4	...	12–15	J. S.	..	F. F.	S. G.	3 & R.	S.	..	W.	81	3 × 28	P. S.	R.	S.	2	1250	1,200
Wayne Model A......	2 H.	5 × 5	...	16	J. S.	..	F. F.	P.	....	C.	..	W.	80	3½ × 30	P. S.	R.	S.	2	1550	1,200
Buick Model C	2 H.	4½ × 5	...	22	J. S. B.	..	F. F.	P.	....	C.	..	W.	87	3½ × 30	A. S.	T.	S.	4	1740	1,200
Duryea 3-wheeled....	3 I.	4½ × 4½	...	12–15	L. T. M.	W.	F. F. & S.	P.	2 & R.	C.	..	..	75	3 × 30	A. W.	P.	S.	2	1000	1,200
Ford Model F......	2 H.	4½ × 4	...	12	J. S.	..	S. F.	P.	2 & R.	C.	..	W.	84	3½ × 30	A. I.	T.	S.	4	1450	1,200
Model Style C..	2 H.	4½ × 5	...	12	J. S.	..	F. F.	S. G.	....	C.	..	W.	86	3 × 30	A. S.	T.	S.	4	1200	1,200
Union Model E	2 H.	6 × 4	...	16	J. S.	..	A.	F.	....	F.	..	W.	94	3½ ×	A. S.	T.	S.	4	1800	1,200
Reliance........	2 H.	4½ × 5½	...	18–22	J. S.	..	F. F. & S.	S. G.	....	C.	..	W.	92	3½ × 32	P. S.	T.	S.	4	1750	1,250
Auburn Model B......	2 H.	5 × 4	...	18	J. S.	..	F. F.	P.	2	C.	..	W.	92	3½ × 30	A. S.	T.	S.	4	1750	1,250
Pierce-Racine Model B2.....	2 V.	....	...	16	J. S.	..	F. F.	P.	3 & R.	C.	..	W.	90	3 × 30	A. S.	T.	S.	4	1620	1,250
Elmore Pathfinder...	2 H.	4½ × 4	...	16–18	J. S.	..	A.	P.	2 & R.	C.	1	W.	88	3½ × 30	A. S.	T.	S.	4	1550	1,250
Reo Touring Car...........	2 H.	4½ × 6	...	16	J. S.	..	S.	P.	....	C.	..	W.	88	3½—	P. S.	T.	S.	4	1400	1,250
Knox Model E......	1	5 × 8	...	8–10	J. S.	..	F. F.	P.	....	C.	..	L.	78	3½ × 30	A. S.	S.	S.	2 or 4	1700	1,250
Sommer Car...........	2 H.	4½ × 5	...	15	....	..	....	P.	2 & R.	..	..	..	80	....	P. S.	D. T.	R.	4	...	1,250
Premier Model F......	4 V.	3½ × 4½	...	16	J. S.	A.	A.	P.	....	C.	..	W.	96	3½ × 32	A. S.	R.	S.	2	1400	1,250
Michigan Model E......	2 H.	4½ × 5	...	....	J. S.	..	F. F.	P.	2 & R.	C.	..	W.	80	3½ × 30	A. S.	T.	S.	4	1800	1,250
Duryea Phaeton......	3 I.	4½ × 4½	...	12–15	L. T. M.	W.	S.	P.	3 & R.	C.	..	L.	75	3 × 30	A. W.	P.	S.	2	1800	1,300

NAME.	Motor.				Ignition.	Cooling.	Lubrication.	Transmission.			Brakes.	Steering.	Wheels.		Frame.	Body.			Weight.	Price.
	No. of cylinders.	Bore & Stroke.	R. P. M.	B. H. P.				Kind.	Speeds.	Drive.			Base.	Tires.		Kind.	Entrance.	Seats.		
Stevens - Duryea Model L	2 H.	4½ × 4½	600	7	J. S. B.	W.	S. F.	I. C.	3 & R.	C.	2	L.	69	28×3	P. S.	S.	S.	2-4	1350	**$1,300**
Haynes Model L	2 H.	5 × 5	...	16-18	J. S.	W.	F. F.	I. C.	3 & R.	C.	1	W.	82	3½×32	A. I.	S.	S.	4-2	1500	**1,350**
Studebaker No. 9502	2 H.	5 × 5½	...	16	J. S. B.	..	S. F.	P.	....	C.	..	W.	82	3½×30	A. W.	T.	S.	4	...	**1,350**
Waterloo Phaeton	3 I	4½ × 4½	...	10-12	M.	..	A.	P.	....	C.	..	L.	72	3×36	B. W.	P.	S.	2	1000	**1,350**
Rambler Surrey Type 1	2 H.	5 × 6	...	18	J. S.	..	G.	P.	....	C.	..	W.	90	3½×30	P. S.	T.	S.	4	2000	**1,350**
Zent	3	4½ × 4½	...	18	J. S.	A.	F. F.	P.	....	S.	..	..	90	3½×30	A. S.	T.	S.	4	1400	**1,350**
Auto-car Type 8	2 H.	4 × 4	...	12	J. S. B.	..	S.	S. G.	3 & R.	S.	2	W.	76	3½×30	A. W.	T.	R.	4	1700	**1,400**
Oldsmobile	2 H.	5¼ × 6	...	20	J. S.	W.	F. F.	P.	2 & R.	C.	2	W.	90	4×30	A. S.	T.	S.	4	...	**1,400**
Maxwell Model H	2 H.	5 × 5	1500	16	J. S.	W.	F. F.	S. G.	3 & R.	S.	2	W.	88	3½×30	P. S.	T.	S.	4	1750	**1,400**
Franklin Type E	4 V.	3¼ × 3¼	1000	12	J. S.	A.	F. F.	P.	2 & R.	C.	..	W.	80	3×28	A. I.	R.	S.	2	1000	**1,400**
St. Louis	1 H.	6 × 5½	...	12	J. S.	..	F. F.	S. G.	....	C.	..	W.	86	3½×30	A. S.	T.	S.	4	1725	**1,400**
Duryea Folding Rear	3 I.	4½ × 4½	...	12-15	L. T. M.	..	S.	P.	3 & R.	C.	..	L.	78	3×36	A. W.	P.	S.	4	1100	**1,500**
Princess	2 H.	5 × 5	...	16	J. S.	..	....	P.	....	C.	..	W.	82	4×30	....	T.	S.	4	1900	**1,500**
Orient Model E	4 V.	3½ × 4½	...	15	J. S.	A.	S.	S. G.	....	S.	..	W.	82	3½×30	P. S.	R.	S.	2	1300	**1,500**
Model Style B	2 H.	4½ × 7	...	15	J. S.	..	F. F.	S. G.	4	C.	..	W.	86	3½×32	A. S.	T.	R.	4	1400	**1,500**
Knox Model F1	2 H.	5 × 6	...	14-16	J. S.	A.	F. F.	P.	....	C.	..	W.	81	4×30	A. S.	R.	S.	2	1850	**1,500**
Franklin Type A	4 V.	3¼ × 3¼	...	12	J. S.	A.	F. F.	P.	2 & R.	C.	..	W.	80	3×28	A. I.	R.	S.	2	1100	**1,500**
Walworth	2 H.	4 × 5½	...	14	J. S.	..	S.	P.	....	S.	..	W.	80	— 28	A. S.	D. T.	R.	4	1500	**1,500**
Marble-Swift	4 V.	....	...	18-22	....	..	F. F.	F.	....	C.	..	W.	90	3½×28	....	D. T.	R.	4	1600	**1,500**
Premier Model F	4 V.	3¾ × 4½	...	16	J. S.	A.	A.	P.	....	C.	..	W.	96	3½×32	A. S. & W.	T.	S.	4	1600	**1,500**
Columbia Mark XLIII	2 H.	4¼ × 5	...	12-14	J. S. B.	..	F. F.	S. G.	....	S.	..	W.	82	3½×30	P. S.	T.	R.	4	1800	**1,500**

Mitchell	4 V.	4¼ × 4½	...	18–20	J. S.	A. or W.	F. F.	S. G.	3	S.	..	W.	90	3½ × 30	P. S.	T.	S.	4	1750	**1,500**
Dolson Model C	2 H.	5¼ × 6	...	20	J. S.	..	F. F.	P.	2 & R.	C.	..	W.	90	3½ × 30	A. S.	T.	S.	4	2000	**1,500**
Northern	2 H.	5½ × 5½	1000	18	J. S. B.	W.	F. F.	P.	....	S.	2	W.	88	4 × 34	A. S.	T.	S.	2	1800	**1,500**
Haynes Model M	2 H.	5 × 5	...	16–18	J. S.	W.	F. F.	I. C.	3 & R.	S.	1	W.	82	3½ × 32	R. S.	D. T.	S.	4	1500	**1,500**
Marion	4 V.	4 × 4	...	16	J. S.	..	S.	P.	....	C.	..	W.	96	3½ × 30	A. W.	T.	S.	4	1650	**1,500**
Brew-Hatcher Car	2 H.	4½ × 5½	...	16	J. S.	..	F. F. & S.	S. G.	....	S.	..	..	92	3½ × 30	....	...	S.	4	1700	**1,500**
Logan Model D	2 H.	4½ × 5	...	20	J. S.	..	A.	S. G.	....	C.	..	W.	90	3½ × 30	A. S.	T.	S.	4	1620	**1,600**
Wolverine Model D	2 H.	5 × 5	...	16–20	J. S.	..	F. F.	S. G.	3	S.	..	W.	88	3½ × 30	A. S.	T.	S.	4	1700	**1,600**
St. Louis	2 H.	5 × 5	...	16	J. S.	..	F. F.	S. G.	....	S.	..	W.	86	3½ × 30	A. S.	T.	S.	4	1725	**1,600**
Pope-Hartford Model D	2 H.	4½ × 4½	1300	16	J. S.	..	F. F. & S.	S. G.	3 & R.	S.	2	W.	88	3½ × 30	A. W.	T.	S.	4	1950	**1,600**
Moline Model B	4 V.	4 × 4½	...	18–20	J. S.	..	A.	P.	....	S.	..	W.	105	3½ ×	P. S.	T.	S.	4	1700	**1,600**
Orient Model F	4 V.	3½ × 4½	...	15	J. S.	A.	S.	S. G.	....	S.	..	W.	82	3½ × 30	P. S.	T.	F.	4	1450	**1,650**
Franklin Type A	4 V.	3¼ × 3½	...	12	J. S.	A.	F. F.	P.	....	C.	..	W.	80	3 × 28	A. I.	...	R.	4	1100	**1,650**
Acme Type VI	2 V.	4 × 5	...	16	J. S.	..	A.	S. G.	3 & R.	S.	..	W.	89	3½ × 30	A. W.	T.	R.	4	1920	**1,650**
Pungs-Finch Model D	4 V.	4 × 4	...	20	J. S.	..	F. F.	S. G.	....	S.	..	W.	80	3½ × 30	P. S.	T.	R.	4	1750	**1,700**
Berkshire	4 V.	4 × 4	...	18	J. S.	..	F. F.	I. C.	....	S.	..	W.	86	3½ × 30	P. S.	D. T.	S.	4	1500	**1,750**
Knox Model F-3	2 H.	5 × 6	...	14–16	J. S. B.	..	F. F.	P.	....	C.	..	W.	87	4 × 30	A. S.	D. T.	S.	4	1950	**1,750**
Duquesne Model C	4 V.	3½ × 4	...	16–21	J. S.	A.	F. F. & S.	S. G. & P.	4 & R.	S.	..	W.	90	3½ × 32	P. S.	T.	S.	4	1650	**1,750**
Richmond	4	3¾ × 4	...	....	J. S. M.	A.	....	I. C.	3 & R.	S.	..	..	90	3½ × 30	A. S. & A. W.	T.	S.	4	1600	**1,750**
Columbia Mark XLIV	2 H.	4½ × 5	...	18	J. S. B.	W.	F. F.	S. G.	....	S.	..	W.	82	3½ × 30	P. S.	T.	S.	4	1800	**1,750**
Waterloo	3 I.	4½ × 4½	...	12–15	L. T. M.	W.	A.	P.	....	C.	..	L.	84	3½ × 36	A. S. & W.	P.	S.	..	1600	**1,750**
Northern	2 H.	5½ × 5½	1000	18	J. S. B.	W.	F. F.	P.	2 & R.	S.	2	W.	100	4 × 34	A. S.	T.	S.	4	2000	**1,770**
Winton Model C	4 V.	3½ × 5	...	....	L. T. M.	W.	F. F.	I. C.	....	S.	1	W.	88	3½ × 30	P. S.	T.	S.	4	1800	**1,800**
Blood Bros	2 H.	5 × 5	...	16	J. S. B.	..	F. F.	S. G.	4	S.	..	W.	92	3½ × 30	A. W.	T.	S.	4	1775	**1,800**
Pungs-Finch Model F	4 V.	4 × 4½	...	24	J. S.	..	F. F.	S. G.	....	S.	..	W.	97	3½ × 32	P. S.	T.	S.	4	1800	**1,850**

NAME.	Motor.				Ignition.	Cooling.	Lubrication.	Transmission.			Brakes.	Steering.	Wheels.		Frame.	Body.			Weight.	Price.
	No. of cylinders.	Bore & Stroke.	R. P. M.	B. H. P.				Kind.	Speeds.	Drive.			Base.	Tires.		Kind.	Entrance.	Seats.		
Knox Model F	2 H.	5 × 6	...	14-16	J. S. B.	A.	F. F.	P.	....	C.	..	W.	90	4×30	A. S.	T.	S.	4	2000	$1,900
E. H. V. Compound	3 V.	1, 5½×5½ 2, 5½×10	...	24-28	J. S.	W.	F. F.	S. G.	3 & R.	C.	..	W.	100	4×34	P. S.	T.	S.	4	2150	2,000
Model Style A	2 H.	5 × 7	...	20	J. S.	..	F. F.	S. G.	....	C.	..	W.	92	3½×32	A. S.	T.	S.	4	1600	2,000
Orient Model G	4 V.	4 × 4½	...	20	J. S.	A.	S.	S. G.	....	S.	..	W.	96	3½×32	P. S.	T.	S.	4	1650	2,000
Ford Model B	4 V.	4¼ × 5	...	20	J. S.	W.	S. F.	P.	....	S.	..	W.	92	3½×32	P. S.	T.	S.	4	1750	2,000
Queen Model D	4 H.	4¼ × 4½	...	24	J. S.	..	....	P.	....	..	..	W.	96	— 32	A. S.	T.	S.	4	...	2,000
Corbin Model D	4 V.	3½ × 4½	1500	16-20	J. S.	A.	F. F. & S.	S. G.	3 & R.	S.	2	W.	94	3½×30	P. S.	T.	S.	4	1750	2,000
Auto-car Type 11	4 V.	3¾ × 4	...	16-20	J. S.	W.	F. F. & S.	S. G.	3 & R.	S.	2	W.	96	3½×30	A. W.	T.	S.	4	1900	2,000
Rambler Surrey Type 2	2 H.	5 × 6	...	20	J. S.	W.	A.	P.	....	C.	..	W.	100	4×32	P. S.	T.	S.	4	2200	2,000
Bates Model V	3	4½ × 5	...	....	J. S.	..	F. F. S.	I. C.	3 & R.	S.	..	W.	92	4×30	....	T.	S.	4	1850	2,000
Stoddard-Dayton	4	4 × 4	...	26	J. S.	..	F. F.	S. G.	3	S.	..	W.	96	3½×32	P. S.	T.	S.	4	1800	2,000
Wayne Model C	4 V.	4 × 5	...	....	J. S.	..	F. F.	S. G.	....	S.	..	W.	102	3½×32	P. S.	T.	S.	4	1650	2,000
St. Louis	3 V.	4½ × 5	...	20-24	J. S.	W.	F. F. & S.	S. G.	....	S.	..	W.	86	4×30	A. S.	T.	S.	4	2200	2,100
Covert Model B	4 V.	4 × 4½	...	24	J. S.	W.	F. F. & S.	S. G.	2 & R.	S.	2	W.	94	3½×32	P. S.	T.	S.	4	1740	2,250
Berkshire Model B	4 V.	4½ × 5	...	30	J. S.	..	F. F.	I. C.	....	S.	..	W.	109	4×34	P. S.	T.	S.	4	2000	2,400
Adams Model 6	3 H.	5 × 4½	900	20-25	J. S. B.	A.	F. F.	P. & S. G.	4 & 2 R.	C.	1	L.	84	4½×34	A. I.	Br.	S.	4	...	2,500
Williams	4 H.	4½ × 4½	...	25	J. S.	A.	F. F.	S. G.	3 & R.	..	..	W.	96	3½×36	P. S.	T.	F.	4	1800	2,500
Iroquois	4 V.	4½ × 5	...	24	J. S.	..	F. F.	S. G.	3 & R.	S.	..	W.	100	4 —	S.	T.	S.	4	1950	2,500
Phelps Model C	3	4½ × 4½	...	20-24	L. T. M.	W.	A.	I. C.	3 & R.	S.	..	W.	104	4×32	None	T.	S.	4	1900	2,500
Yale Model F	4 V.	4½ × 4½	...	24-28	J. S. M.	W.	F. F.	S. G.	3 & R.	S.	1	W.	104	4×32	A. S.	T.	S.	4	2300	2,500
Dolson Model B	4 V.	4½ × 4½	...	28-30	J. S.	..	F. F.	S. G.	3 & R.	S.	..	W.	108	4×34	P. S.	T.	S.	4	2200	2,500

Winton Model B......	4 V.	4½ × 5	...	....	L. T. M.	W.	F. F.	I. C.	....	S.	..	W.	102	4×32	P. S.	T.	S.	4	2100	2,500
Frayer-Miller .	4	4 1/16 × 5 1/16	...	24	J. S. B.	A.	F. F.	S. G.	3 & R.	S.	..	W.	96	3½×32	P. S.	D. T.	S.	4	1800	2,500
Meteor..........	4 V.	....	1800	18	J. S. B.	W.	F. F.	S. G.	3 & R.	S.	1	W.	91	3½×32	P. S.	T.	S.	4	1700	2,500
Upton Model B......	4	4½ × 4½	...	30	J. S. M.	..	F. F. & S.	S. G.	3	S.	..	W.	100	4×34	P. S.	T.	S.	4	2000	2,500
Northern.......	2 H.	5¼ × 5½	...	18	J. S.	..	F. F.	P.	....	S.	..	W.	102	4×34	A. S.	L.	S.	4	2300	2,500
Hammer Model H......	4 V.	4¼ × 4½	...	24	J. S.	W.	F F.	P. or S. G.	....	S.	1	W.	100	4×32	P. S.	T.	S.	4	1800	2,500
Stevens - Duryea Model R.	4 V.	3⅞ × 4½	...	20	J. S. B.	..	S. F.	S. G.	....	S.	..	W.	90	3½×30	P. S.	T.	S.	4	1650	2,500
Marmon Model B......	4 I.	4 × 4	...	20	J. S.	A.	F. F.	P.	....	S.	1	W.	90	4×32	P. S.	T.	S.	4	2000	2,500
National Model C	4 V.	4½ × 5	...	25–30	J. S.	..	S.	S. G.	....	S.	..	..	..	4×34	P. S.	...	S.	4	...	2,500
Gaeth Triplex .	3 H.	5 × 6	...	25–30	....	W.	....	P.	2 & R.	C.	..	W.	..	....	....	T.	S.	4	...	2,600
Schacht.........	4 H.	4½ × 4½	...	....	J. S. D. & B.	..	F. F.	P.	....	S.	..	W.	102	4×34	P. S.	...	S.	4	2100	2,600
Acme Type 8.........	4 V.	4 × 5	...	30	J. S. M.	..	F. F.	S. G.	4 & R.	C.	..	..	102½	4×34	P. S.	T.	S.	4	2275	2,750
Berg	4 V.	4 × 5	600	24	J. S. B.	..	F. F.	S. G.	3 & R.	C.	2	W.	96	4×34	A. W.	T.	R.	4	2300	2,750
Pope-Toledo Model X......	4 V.	4½ × 4½	1200	20	J. S.	W.	....	S. G.	3 & R.	C.	1	W.	88	3½×32	P. S.	T.	S.	4	1800	2,800
Locomobile Model E......	4 V.	3¾ × 4¼	...	15–20	L. T. M.	W.	F. F.	S. G.	3 & R.	C.	3	W.	92	4×32	P. S.	T.	S.	4	1800	2,800
Cadillac Model D......	4 V.	4⅜ × 5	...	30	J. S.	W.	F. F.	P.	....	S.	..	W.	100	4½×34	P. S.	T.	S.	4	2600	2,800
Cleveland Model C.......	4 V.	3½ × 4½	...	18	....	W.	....	S. G.	3 & R.	..	..	..	91	3½×32	P. S.	...	S.	4	1800	2,800
Austin Model 35.....	4 V.	4½ × 5	...	35	J. S.	..	F. F.	S. G.	4	S.	..	W.	108	4×36	A. S.	T.	S.	4	2400	3,000
Royal Model F......	4 V.	5 × 5¼	...	32–38	J. S. B.	..	F. F.	S. G.	3	S.	..	W.	108	4½×34	P. S.	T.	S.	4	2500	3,000
Thomas Model 25.....	4 V.	....	1200	40	J. S.	W.	....	S. G.	3 & R.	C.	3	W.	104	4½×34	P. S.	T.	S.	4	2600	3,000
Berg............	4 V.	4 × 5	...	24	J. S. B.	W.	F. F.	S. G.	3 & R.	C.	3	W.	96	4×34	A. W.	T.	S.	4	2300	3,000
Rambler........	2 H.	5 × 6	...	20	J. S.	W.	G.	P.	....	C.	..	W.	100	4½×34	P. S.	L.	S.	4	2400	3,000
Studebaker No. 9503......	4 V.	3⅞ × 4½	...	20	J. S.	W.	F. F.	S. G.	....	..	..	W.	96	4×32	P. S.	T.	S.	4	...	3,000
Haynes Model K......	4 V.	5 × 5	...	35–40	J. S.	W.	F. F.	I. C.	3 & R.	S.	2	W.	108	4½×34	P. S.	T.	S.	4	2750	3,000

NAME.	Motor. No. of cylinders.	Motor. Bore & Stroke.	Motor. R. P. M.	Motor. B. H. P.	Ignition.	Cooling.	Lubrication.	Transmission. Kind.	Transmission. Speeds.	Transmission. Drive.	Brakes.	Steering.	Wheels. Base.	Wheels. Tires.	Frame.	Body. Kind.	Body. Entrance.	Body. Seats.	Weight.	Price.
Pope-Toledo Model 7.......	4 V.	4½ × 5¼	1200	30	J. S.	W.	....	S. G.	3 & R.	C.	2	W.	96	4×34	P. S.	T.	S.	4	2350	$3,200
Peerless Model 9.......	4 V.	....	...	24	J. S.	..	F. F.	S. G.	4	S.	..	W.	102	4×34	P. S.	T.	S.	4	2400	3,200
Standard.......	4	4½ × 5	...	24	L. T. M.	W.	F. F.	S. G.	3 & R.	S.	2	W.	109	4×34	P. S.	T.	S.	4	2200	3,500
Packard Model N......	4 V.	4 1/16 × 5⅛	...	28	J. S.	W.	F. F.	S. G.	4 & R.	S.	2	W.	106	4×34	P. S.	T.	S.	4	2350	3,500
Franklin Type C.........	4	5 × 5	...	30	....	A.	....	S. G.	....	S.	..	W.	107	4½×34	....	T.	S.	..	2400	3,500
Ardsley.........	4 V.	4¾ × 5½	...	20–35	J. S. D.	W.	F. F.	S. G.	....	S.	..	W.	100	4×34	P. S.	T.	S.	4	2250	3,500
Barnhart......	4 V.	5 × 6	...	44	....	W.	...	....	....	..	..	W.	110	4½×34	....	T.	S.	4	...	3,500
Royal Model F	4 V.	5 × 5¼	...	32–38	J. S. B.	..	F. F.	S. G.	3	S.	..	W.	108	4½×34	P. S.	T.	S.	4	2500	3,500
Austin Model L......	4 V.	5¼ × 5	...	50	J. S.	..	F. F.	S. G.	4	S.	..	W.	108	4½×36	A. S.	T.	S.	4	2500	3,500
Winton Model B......	4 V.	4⅝ × 5	...	....	L. T. M.	W.	F. F.	L. C.	....	S.	..	W.	102	4×32	P. S.	L.	S.	4	2100	3,500
Thomas Model 29.....	4 V.	....	...	50	J. S.	W.	....	S. G.	3 & R.	C.	..	W.	114	4½×34	P. S.	V.	S.	4	2650	3,500
Pope-Toledo Model 8.......	4 V.	4½ × 5¼	...	30	J. S.	W.	....	S. G.	3 & R.	C.	..	W.	100	4×34	P. S.	T.	S.	4	2450	3,500
Apperson.......	4 V.	5 × 5	...	24–30	....	W.	F. F.	S. G.	4	C.	..	W.	104	....	P. S.	T.	S.	4	2300	3,650
Locomobile Model D......	4 V.	4 × 5	...	20–25	J. S.	W.	A.	S. G.	3	C.	3	W.	96	4×34	P. S.	T.	S.	4	2300	3,700
Peerless Model 10.....	4 V.	....	...	30	J. S.	..	F. F.	S. G.	4	S.	..	W.	104	4×34	P. S.	T.	S.	4	2600	3,750
"Great Arrow"......	4 V.	5⅛ × 4¾	1600	24–28	J. S.	W.	A.	S. G.	3 & R.	S.	..	W.	104	4×34	P. S.	T.	S.	4	2500	4,000
Buffum Model K......	4 V.	4½ × 5¼	...	28	L. T. M. & J. S.	W.	F. F.	S. G.	....	C.	..	W.	105	3½×36	P. S.	T.	S.	4	2000	4,000
Chadwick Type 9........	4 V.	4¼ × 5	...	24–32	J. S. B.	..	S. F.	S. G.	4 & R.	C.	..	W.	107½	4½×34	P. S.	T.	S.	4	2500	4,000
Stearns.........	4 V.	4⅞ × 5¼	...	40	J. S. M.	W.	S.	S. G.	4 & R.	C.	2	W.	118	4½×34	P. S.	T.	S.	4	2700	4,000
Welsh Touring Car	4 V.	4½ × 5	...	30–36	J. S.	W.	F. F.	I. C.	....	S.	..	W.	114	4½×36	P. S.	T.	R.	4	2800	4,000

The Lozier Car	4 V.	4½ × 5½	...	30–35	J. S. M.	W.	S. F. & S.	S. G.	3 & R.	C.	2	W.	115½	4½ × 36	P. S.	T.	S.	4	2500	4,000
Corbin Model C......	4 V.	4½ × 5½	...	24–30	J. S.	A.	F. F. & S.	S. G.	3 & R.	..	2	W.	106	4 × 34	P. S.	T.	S.	4	2400	4,000
Columbia Mark XLV...	4 V.	5 × 5	...	35–40	J. S. B.	W.	F. F.	....	....	C.	..	W.	108 or 112	4½ × 34	P. S.	V.	S.	4	2840	4,000
Peerless Model 11.....	4 V.	....	...	35	J. S.	..	F. F.	S. G.	4	S.	..	W.	104	4 × 34	P. S.	T.	S.	4	2700	4,000
Apperson......	4 V.	5 × 5	...	40	....	W.	F. F.	S. G.	....	C.	..	W.	110	4 × 32	P. S.	T.	S.	4	2400	4,150
Wood's.........	4 V.	5 × 5	...	40	J. S.	W.	F. F.	S. G.	3 & R.	C.	2	W.	108	4½ × 36	P. S.	T.	S.	4	2500	4,250
Winton Model A......	4 V.	5½ × 6	...	....	L. T. M.	W.	F. F.	I. C.	....	S.	..	W.	106	4½ × 34	P. S.	L.	S.	4	2400	4,500
Winton Model B......	4 V.	4½ × 5	...	....	....	W.	F. F.	I. C.	....	S.	..	..	102	4 × 32	P. S.	...	S.	4	2100	4,500
Thomas Model 29.....	4 V.	....	...	50	J. S.	W.	....	S. G.	3 & R.	C.	..	W.	114	4½ × 34	P. S.	...	S.	4	2750	4,500
Speedway......	4 V.	4½ × 5	...	28	J. S. B. & M.	W.	S. F. & S.	S. G.	4 & R.	S.	..	W.	108	4½—	P. S.	T.	S.	4	2400	4,700
Sturtevant.....	6 H.	4½ × 5	...	40–45	J. S. M.	W.	A.	Sp.	....	S.	..	W.	108	4½—	P. S.	T.	S.	4	3000	5,000
Matheson.......	4 V.	4½ × 6	...	24	L. T. M.	W.	F. F.	I. C.	....	C.	..	W.	106	4½ × 36	A. W.	T.	S.	4	2700	5,000
Woods..........	4 V.	5 × 5	...	40	J. S.	W.	F. F.	S. G.	3 & R.	C.	2	W.	108	4 × 36	P. S.	L.	S.	4	2900	5,000
Peerless Model 12.....	4 V.	....	...	60	J. S. & L. T. M.	..	F. F.	S. G.	4	S.	..	W.	107	4½ × 36	P. S.	T.	S.	4	2900	6,000
Thomas Model 27.....	6 V.	....	...	60	J. S.	W.	....	S. G.	3–4 & R.	C.	..	W.	124	4½ × 36	P. S.	S.	S.	3	2204	6,000
Locomobile Model H......	4 V.	4½ × 5½	...	30–38	L. T. M.	W.	F. F.	S. G.	3	C.	..	W.	102	4 × 34	P. S.	L.	S.	4	2500	6,000
Simplex........	4 V.	4½ × 5½	...	30	J. S.	W.	F. F.	S. G.	4 & R.	C.	3	W.	106	....	P. S.	T.	S.	4	2090	6,885
American Mercédès.....	4 V.	....	...	40	L. T. M.	W.	S. F.	S. G.	4 & R	C.	..	W.	..	....	....	T.	S.	4	....	7,500
American Napier........	6 V.	...	...	30	J. S.	W.	....	S. G.	3–4 & R.	C.	3	W.	108	36—	P. S.	O.	S.	4	2800	9,250
Pope-Toledo Model 9.......	4 V.	5 × 5½	...	45	J. S.	W.	....	S. G.	3 & R.	C.	2	W.	104	4½ × 34	P. S.	T.	S.	4	2650	6,000

FOREIGN CARS OF 1905 ON THE AMERICAN MARKET.

NAME.	Motor.				Ignition.	Cooling.	Lubrication.	Transmission.			Brakes.	Steering.	Wheels.		Frame.	Body.			Weight.	Price.
	No. of cylinders.	Bore & Stroke.	R. P. M.	B. H. P.				Kind.	Speeds.	Drive.			Base.	Tires.		Kind.	Entrance.	Seats.		
Panhard	4 V.	......	...	10	J. S. D.	W.	F. F.	S. G.	4 & R.	C.	..	W.	102	×54	A. W.	To order.			2600	$ 3,550
Renault	4 V.	......	...	20–30	......	W.	F. F.	S. G.	3 & R.	C.	..	W.	102	×50	P. S.	Chassis only.			2000	4,950
Darracq	4 V.	......	...	15–20	......	W.	F. F.	S. G.	3 & R.	C.	..	W.	97	×52	......	P.	..	6	1760	5,000
Hotchkiss	4 V.	......	...	17–32	......	W.	F. F.	S. G.	....	C.	..	W.	....	....	P. S.	Chassis.			2000	5,000
Richard-Brazier	4 V.	......	...	16–22	......	W.	F. F.	S. G.	4 & R.	C.	..	W.	....	×54	Comb.	T.	S.	5	2000	5,700
Minerve	4 V.	......	...	25	......	W.	F. F.	S. G.	3 & R.	C.	..	W.	....	....	P. S.	T.	S.	5	1900	6,500
Benz-Parsifal	4 V.	......	...	22	......	W.	F. F.	S. G.	4 & R.	C.	..	W.	....	....	A. W.	T.	..	6	2200	7,500
Delahaye	4 V.	......	...	25–32	......	W.	F. F.	S. G.	3 & R.	C.	..	W.	....	....	P. S.	T.	S.	5	2600	7,500
Pipe	4 V.	......	...	20	......	W.	F. F.	S. G.	4 & R.	C.	..	W.	....	....	P. S.	T.	S.	5	2500	7,800
Bollée	4 V.	......	...	20–32	......	W.	F. F.	S. G.	....	C.	..	W.	....	....	P. S.	T.	S.	5	2200	8,000
Darracq	4 V.	......	...	30–35	......	W.	F. F.	S. G.	3 & R.	C.	..	W.	100	×56	S.	P.	..	6	2060	8,000
F. I. A. T.	4 V.	......	...	....	......	W.	F. F.	S. G.	4 & R.	C.	..	W.	121	×56	P. S.	T.	S.	6	2500	8,500
Clement-Bayard	4 V.	......	...	45	......	W.	F. F.	S. G.	3 & R.	C.	..	W.	....	....	A. W.	T.	S.	7	2500	8,750
Mercedes	4 V.	......	...	28–32	......	W.	F. F.	S. G.	4 & R.	C.	..	W.	96	×32	P. S.	T.	S.	7	3000	8,900
Pequeot	4 V.	......	...	30–35	......	W.	F. F.	S. G.	4 & R.	C.	..	W.	....	....	P. S.	T.	S.	5	2450	9,000
Martini	4 V.	......	...	30–40	......	W.	F. F.	S. G.	4 & R.	C.	..	W.	96	×52	P. S.	T.	S.	7	....	9,500
Mors	4 V.	......	...	40–52	......	W.	F. F.	S. G.	4 & R.	C.	..	W.	....	....	P. S.	Chassis.			2400	9,500
Rochet-Schneider	4 V.	......	...	50	......	W.	F. F.	S. G.	4 & R.	C.	..	W.	118	×55	S.	Chassis.			2100	10,000
Decauville	4 V.	......	...	45–60	......	W.	F. F.	S. G.	3 & R.	C.	..	W.	....	....	P. S.	Br.	S.	7	3000	10,500
C. G. & V.	4 V.	......	...	40	......	W.	F. F.	S. G.	4 & R.	C.	..	W.	....	....	A. W.	L.	S.	8	2700	11,000
Panhard	4 V.	......	...	70	J. S. D.	W.	F. F.	S. G.	4 & R.	C.	..	W.	108	×54	A. W.	To order.			2900	11,700
Hotchkiss	4 V.	......	...	30–45	......	W.	F. F.	S. G.	4 & R.	C.	..	W.	....	....	P. S.	Lan.	S.	6	2500	12,000
De Dietrich	4 V.	......	...	60	.. ...	W.	F. F.	S. G.	4 & R.	C.	..	W.	107	....	A. W.	L.	S.	6	3500	13,000

CHAPTER X

HOW TO RUN AN AUTOMOBILE

"A HORSE," says Rudyard Kipling, "in most harnesses does the work for which his driver is paid; and when the man is more than usual drunk the beast will steer him home. Not so the car. She demands of her driver a certain standard of education, the capacity of unflickering attention and absolute sobriety."

Given the supply for these demands, there is one thing more needed to make a really successful driver, viz.: *rapport* between the driver and machine—a *rapport* of the kind Mr. Kipling has sung of in MacAndrew's Hymn. It is comparatively easy to learn to go through the motions of starting, steering, and stopping, but to get the highest pleasure as well as the highest efficiency out of an automobile, the driver must become the soul of the mechanism. A good driver is a good listener. Like a locomotive engineer, he comes to distinguish instantly between the sweetness of normal running and the slight noises that indicate something is wrong. Stand on any corner past which many motor-vehicles run and listen attentively to the sounds

made by each. You will be surprised to find how they differ in different cars. Not all the noisy cars are running badly, but you will very quickly pick out those whose even, rhythmical sound tells of properly timed ignition, and of throttling adjusted to a nicety for the speed. If you are observant, a few rides in an automobile driven by experienced hands will make you more or less familiar with the sources of different sounds. You will learn the difference between the explosions in the cylinder and the chug of the exhaust, and you will note how each differs under different running conditions. But more of this in the chapter on Care.

While you are training your ear to distinguish noises, you may very profitably take a few lessons in steering, getting your friend the driver to put the machine at the first speed on some broad, level stretch of road. With both hands on the tiller or steering-wheel you will endeavor to lay a straight course in the middle of the road, and you will be astonished to find what a wobbly job you make of it. The machine, especially if it be a light one with reversible steering-gear, will be much more sensitive to your inexperienced touch than you supposed. You will turn too far in one direction, and in trying to correct the error you will go to the other extreme, so that your experienced friend will probably be kept busy at first working the clutch, and perhaps the brake-pedal, to prevent your zigzagging entirely off the road. At first, your grasp will be that of a drowning man, but as you gain

A FRIENDLY BRUSH ON THE ROAD BETWEEN TWO STEAM-CARS OF THE SAME DESIGN AND POWER.

confidence you will learn to hold the tiller lightly except when it is necessary to apply some force.

You will soon get over your zigzagging, and will find that you can keep a straight course mainly with one hand. Let the driver then reverse the car and give you an opportunity to acquire the same proficiency in steering backward. Before proceeding to the next speed, you had better try operating the brake-pedal yourself and also throwing the clutch in and out. In most cars the brake-pedal throws the clutch out automatically. Remember to start and stop gradually. Depress the brake-pedal slowly, with increasing force as you feel the brake bind. Before releasing the brake at starting, plant your heel firmly on the foot-board, depress the clutch-pedal with the toe. Then release the brake and, slowly raising your toe, let the pedal slide up along the sole of your foot till the clutch is engaged. This will give you the most delicate control.

The next time you go out with your experienced friend, you may try straight steering on the second speed. The higher the speed, the easier to keep a straight course, but it is best to pick out a level field or some other arena before attempting the intricacies of curves and turning. Set up a few obstacles of some material no more formidable than a pasteboard bandbox and practise turning in and out for these, steering between them in about the position of Scylla and Charybdis and rounding them at different speeds as imaginary corners. In general, you had best form the excellent habit of

taking corners with your clutch-pedal down and your foot on the brake-pedal, either operating it or ready to do so. Turning corners at high speed is dangerous at any time and puts a very undesirable strain upon your wheels and tires. Always depress your clutch-pedal sharply and suddenly and let it up slowly and gradually. Never apply the brakes so suddenly as to lock the wheels. If the momentum of the car is sufficient to cause the wheels to slide, they *will* slide, and slide faster than if braked just up to the point where they still roll. In a light tonneau with no passengers, so little of the moving weight is over the drive-wheels that if they be locked suddenly, friction would almost instantly melt the tires and so lubricate the slide of the wheels as to offer less resistance to rolling than ordinary running. Furthermore, surface pebbles and sand will make excellent ball-bearings for the wheels to slip over. Overcome early the tendency to panic-stricken braking. If in danger, put the brake on hard but evenly, and no matter how rattled you feel, remember that the friction between rubber and road when the wheels are *not* locked gives greater braking power in proportion to weight than your friend the locomotive engineer has at his command when some one is "asleep at the switch."

But you are anxious to get beyond the point where the experienced motorist is "giving you the steer"; you are eagerly anxious to run your own car. In the first place, go slow. Make up your mind to operate on the first speed until you are

absolutely sure you can get no more pleasure out of driving unless you can go faster.

But before you can even go at all, you must master the art of starting, which begins with filling your oil- and gasoline-tanks and your water-tanks, unless you have an air-cooled motor. *Always fill and measure the contents of all tanks before starting.* The habit of systematic inspection of the mechanism every time you start out should be formed at once. The routine to be gone through is set forth in the chapter "How to Care for an Automobile," which may profitably be studied before taking your first ride. If your experienced friend is still with you—and you had better induce him to stand by you if possible—he will tell you a lot of things you will want to know. If he is not, you will have to learn the mechanism of your car from the maker's instruction-book, and from "trying things." But don't try anything "just for luck" until you have studied out carefully what the effect will be. In any case, it is a good plan to jack the driving-wheels off the ground at your first lesson and thus be able to note the effect of your operations upon the car standing still.

Put on the brake and make sure that the clutch-pedal is down. Set the change-speed lever in the neutral position and the reverse-lever back as far as it will go. Turn on the cock admitting gasoline to the carbureter. Open throttle slightly; push ignition-advance lever back as far as possible, and be *very* careful you do not get it forward by mistake.

The spark-lever and the throttle-lever are most commonly situated on the steering-pillar, but the particular arrangement of these controls in your machine you can study out from the maker's instruction book. (See Fig. 118.)

"Tickle" the carbureter by depressing the float momentarily, allowing the gasoline to flood in. A rubber bulb or other pneumatic device is usually

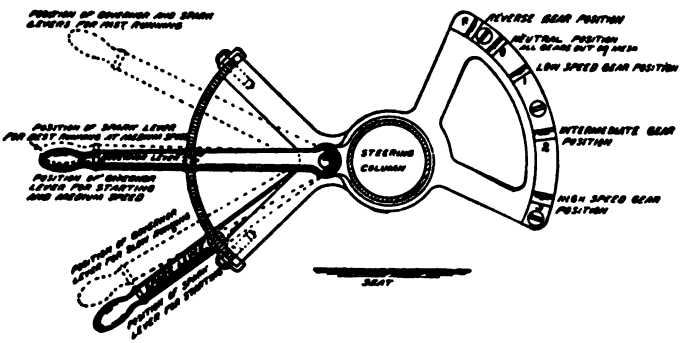


FIG. 118.—DIAGRAM SHOWING POSITIONS OF OPERATING-LEVERS TYPICAL OF CAR WHERE IGNITION-, THROTTLING-, AND SPEED-LEVERS ARE ALL ON STEERING-COLUMN.

provided under the seat for this purpose. Now if the compression in your cylinders is good, you can perhaps start the motor thus: Be sure the ignition circuit is *not* made. Remove the plug from the switch or set it at "off." Put on starting-handle and turn over a few times till a fresh charge is obtained in each cylinder. Then mount the seat, switch on the ignition circuit, and push the sparking-lever sharply forward, as far as it will go.

This, by turning the commutator, will cause a spark in one of the cylinders and start the motor.

If your mechanism will not permit of this method, you will make your ignition circuit, then set on your starting-handle and, making sure that the sparking-lever is as far back as possible, stand facing the handle, grasping it with the four fingers of the right hand, allowing the thumb to lie along the handle. Raise the handle to its highest position, press it in toward the car, and turn downward. As you pass the lowest point and begin to pull upward you should feel the resistance of compression. Should you not feel the compression till you are again pushing downward, do not continue to push, but let the crank spring out of engagement and revolve it backward far enough to pull up against the compression, then shove the crank home and pull it up over the resistance. *Never push down over compression,* for in case the sparking-lever has been left forward, the motor will start before dead center, and the handle will be driven violently backward and will seriously sprain your wrist. One turn may start the motor if you have previously cranked it with the switch "off." If not, you will have to turn over the compression three or four times. It is a good plan for the beginner to make the first two or three turns with the switch "off," and then turn "on" the switch and make the last turn upward, when the motor should start.

Another method for the beginner is to turn the handle till he is sure it is pulling upward against

the compression, then partly open the relief-cock of the cylinder till part of the compression is released, then close it and pull the motor over quickly once. If this does not start it, open the cock partly and pull over three or four times; close the cock and pull over once. Some small motors are provided with an exhaust-valve lifter, which may be operated to relieve compression during the first few pulls and then released for the final pull on the starting-handle. If you pull over against half-compression and the motor starts, of course close the relief-cocks at once. If the motor does not start after four or five turns, it is useless to go on cranking. Go over the ground a second time. Flood the carbureter again by squeezing the bulb. You may have to give it two or three squeezes if the parts are chilled.

When the motor starts, mount the seat and slowly advance the spark-lever till you hear a knocking sound in the cylinders, then draw the lever back slowly till the knock ceases and the motor runs smoothly. Now open the throttle a little more and you will find that you can advance the spark-lever still further and that the motor will go faster. By experimenting with throttle and spark, you will discover that as you throttle down the gas, the motor will go slower, and then as you retard the spark, it will go slower still. Do not retard the spark without *first* throttling the mixture, otherwise the flaming gas will rush out over the exhaust-valve and its stem, to their permanent injury. You will soon learn how far to advance the spark to get

the greatest range of speed out of each change in the quantity and quality of mixture.

You have not yet attempted to transmit motion to the wheels. With the motor running at a medium speed, see that the clutch is depressed, release the brake, and slide the change-speed lever into position for first speed. Now slowly let up the clutch-pedal and the wheels will begin to revolve. If your transmission is of the planetary type, you will merely have to press down slowly on the slow-speed clutch. After noting the running on low speed, throw out the clutch and apply the brake-pedal. Let the clutch in and out several times and practise operating both pedal and hand-brake.

You may now try to master the operation of the change-speed gears. You have been running on first speed. Throw out the clutch and try to move the change-speed lever into the notch for second speed. The movement should be a steady forward shove of the lever, and as the gears should be traveling at the same speed they should engage at once. If the gears "growl," do not try to force the lever. Withdraw it slightly, release the clutch-pedal slightly, and then, depressing it, try again. The object is to have both shafts moving at the same speed at the moment of engagement. The gears must be thrown into mesh sharply or not at all. Never let them grind against each other. In changing from a high speed to a lower, the wheels should be slowed and the clutch-shaft accelerated to bring the gears approximately to the same speed. In

changing from a low to a high speed, theoretically the car should be accelerated and the clutch-shaft slowed. It is impossible to accelerate the wheels, but the motor may be throttled down and used as a brake on clutch-shaft to bring the gears as nearly as possible to the same speed before meshing. Experience alone will make you proficient in operating the sliding-gears, and by a method of trial and error you will eventually get the "feel" for the proper moment to shove the gears firmly and smoothly into mesh without grinding.

On the road you will also come to divine when to change speed to best accommodate running conditions to the motor. You will have become thoroughly familiar with the action of your machine with the wheels jacked up, and will have become fairly proficient in handling it on the level road before you attempt to take any hills. Don't pick out a very steep one for your first attempt. Your motor should be running at a good speed, previously obtained by opening the throttle and advancing the spark-lever. We will suppose you are taking the hill on the third speed. As you ascend, the motor will begin to slow as it feels the load. Retard your spark gradually to meet the working of the motor. When the motor speed falls to about the speed of the gears, it is time to change down to second speed. This must be done quickly and without hesitation. Push down sharply on clutch-pedal, move speed-lever into second notch, and let up clutch-pedal slowly. Don't get nervous and let the

DIFFICULTIES OFF THE ROAD.

Two results of an attempt to drive across country; after pulling the car out of the ditch with block and tackle, a second hole necessitated taxing the motor to its utmost.

clutch in suddenly, or you will overload and stop the motor. Then your only resource will be to apply the hand-brakes to keep the car from running backward. It is advisable for the beginner not to let the motor slow down too much before changing down in hill-climbing. When its speed flags perceptibly, make your change, and don't be too long about it, as the momentum of the car will fall below the point where the motor will prove efficient on second speed, and you will have to get down quickly to first speed. The object on gradients is, as in starting, to utilize, in the push off, all the power of the motor possible at the road tires, without exceeding the limit of adhesion. You must suit the speed to the load, but do not needlessly change speed if you find that, though you are running a little slower, the motor is taking the load comfortably. Simply retard the spark to the point of best efficiency and let her pull you up. With a high-powered touring-car, you have four speeds forward, and intelligent throttling will give you a range of speed between these. Perhaps your reverse speed is different from any of those forward, and you may find that the only way you can get up some hill is to turn around and "crab" it, pulling yourself up on the reverse speed.

In coming down-hill, as the speed begins to overrun the motor, depress the clutch-pedal, and, if the grade is steep, keep the car under control by the hand-brake. On an ordinarily exhilarating coast, throw out the clutch, throw in the high speed,

and let the clutch in again when the car has slowed down to about even speed for this.

If you have been working up a long hill on the low speed, tending to overheat the motor, it is a good plan to throttle down, and to switch off the ignition as you begin the descent, leaving the clutch in. The cessation of firing will give the cylinders a chance to cool. The speed of the car must of course be prevented, by means of the brake, from over-running the motor. As you reach the bottom, switch on the ignition again, open the throttle, and the motor will take up its cycle. Never coast down a very steep hill, but keep the car carefully under control with the brakes. In coming down a hill slowly, after coming up on low speed, do not release the clutch, but throttle down the motor and retard the spark. In small cars with planetary transmission the low speed will probably control the car in descending average grades. If the foot-brake in such a car is insufficient to hold it on a descent, additional braking power can be obtained by switching off the ignition, with the low speed clutched up. At least one of the brakes should operate without releasing the clutch, so that the latter may be *judiciously* employed on grades in connection with the brakes. Suppose you are laboring up a steep hill and the motor suddenly stops. While you are wondering what has happened, the car will begin to move slowly backward, reversing the motion of the motor, the compression of which affords some brakeage. The thing to do is to lock

the wheels at once by means of the hand-brake without throwing out the clutch. The car may gain a little momentum before you realize the necessity of stopping it, and then if you apply a brake which releases the clutch, the car, relieved of the restraint of the motor, will tend to spring backward strongly. If the brake should not hold, and is of the variety that must be released before you can press in the clutch again, you are worse off than you were before, for then the addition of the hand-brake to the braking effect of the motor would probably have held the car. When the car begins to slip backward on a steep grade, and you find you can not control it, you had best jump out promptly and block the wheels with the biggest thing you can pick up quickly. If you prefer sticking to the tiller, steer the car as coolly as you can into some roadside obstacle.

Stopping on an up grade is a thing to be avoided, since, if the car has no sprag to hold it, starting again is an operation requiring some skill. The clutch must be let in very cautiously, and when it just begins to engage, the brakes must be quickly released and the clutch allowed to press firmly in —practically as one operation. Until you can accomplish this successfully your companion may have to dismount and act as a human sprag, by pushing against the car till you get your transmission started. If he is too bulky to climb in again with the car moving slowly, you had better block the wheels, then mount the seat, release your brake,

and do your best to get the clutch in quickly without overloading the motor. Stopping on a down grade presents much the same problem as on an ascent, though of course starting again is simple enough.

Stopping in general demands some attention. The natural tendency of the driver is to release the clutch and apply the brake. The speed of the motor, however, should first be attended to, by throttling down and retarding the spark to the proper point for a stop. This point is where the motor will just run, and after you have managed your car a while you will know exactly where to set the levers. Acquire the habit of moving these automatically to the proper positions, as the first act of stopping. Do not begin by leaving this till you are reminded of it by the racing of the motor. Do not try to see how short you can stop every time. It is well to adjust the motor speed, release the clutch, and let the car slow down as much as possible before applying the brake. Learn to calculate the distance in which you can bring the car to a standstill with least strain and wear on the mechanism, and then time your operations accordingly. Before dismounting always set change-speed lever in neutral position. If the car is to stand only a brief interval, the motor may be allowed to run, but if there is a considerable wait, pull out the ignition-plug and close the lubricating-cocks.

Never throw in the reverse-gear unless the car has come to a full stop. With the planetary type

of transmission, in a very great emergency the reverse may be used as an *additional* brake, but even then should only be applied after the emergency brakes have been given a chance to act. The sud-

FIG. 119.—CONTROLS OF A TYPICAL CAR HAVING PLANETARY TRANSMISSION.

The box to the left of the dash contains the batteries; that to the right the coil and two-point switch so that either battery may be used. The upright foot-lever farthest to the left gives the first speed, and when the hand-transmission lever to the right is moved forward it gives the second or intermediary speed; with the hand-lever moved still farther forward it gives the reverse. The second upright foot-lever to the right gives the top speed on direct drive. The horizontal pedal between the two levers operates the brake on the transmission while the foot-lever farthest to the right is for the emergency-brake on the rear wheels. The throttle is controlled by the wheel directly below the steering-wheel and the ignition by the small lever directly below this.

den application of the planetary reverse is liable to throw you over the dash and to strain the machinery. (See Fig. 119.)

Side-slip or skidding is a danger against which

the automobilist must be constantly on his guard. If the wheels lose their adhesion so that they rotate faster than they advance on the road, they will slip, and they are quite as likely to slip sidewise as forward. If the vehicle be turned sharply, there is a tendency to side-slip because the center of gravity of the car tends to continue its motion in the original direction. Sudden letting in of the clutch, sudden application of the brakes, or a sudden turn of the steering-wheels, may cause the wheels to lose adhesion, and if the momentum of the car is not in line with its direction, the result will be a side-slip more or less dangerous. In rounding a curve the front wheels tend to slip with increasing speed and the back wheels with decreasing speed. Therefore do not accelerate the speed nor apply the brakes on curves. In turning from a straight line the tendency of the front wheels to slip is greater, and in turning from a curve to a straight line the tendency of the back wheels to skid is greater. Transitions from one curve to another must not be made abruptly, hence in rounding a corner make as wide a sweep as possible. If you are on a crowned road which slopes off to a gutter on either side, take the curve so that the swell of the road will be against your outside wheels. On curves it is the inside wheels and not the outside ones that tend to be lifted off the ground by centrifugal force. The crown of the road will act as a bank to overcome this tendency and also to prevent the rear wheels from skidding sidewise. Always

take the inside gutter in rounding a curve on a crowned road, and in general try to bank the outside wheels so that the car will lean inward on curves, like a bicycle.

When side-slip does occur throw out the clutch and bring the car up, by means of the steering-wheel, in the direction of the slip. If the slip occurs while braking, release the brakes and trust to manipulation of the steering-wheel to right the car. Wet asphalt or a moist road where the mud is only surface-dry requires the greatest caution in driving to prevent skidding. Various wheel and tire attachments are sold to prevent skidding, and most of them are useful, but do not expect them to insure you against reckless driving. When you feel the car begin to skid, do not trust to your skill as a driver to swing it around safely, but try to right it at once. Such a strain is put upon the wheels when slipping sidewise, that were one of them to meet an obstacle, the chances are all the spokes would be ripped out from the hub and you would be left disabled if not personally injured.

Do not at any period of your career as an automobilist abuse the privileges of the road nor be inconsiderate of the rights of others. Do not try to show off until you know what you are doing. Do not run over dogs. It will hurt the dog, but it may hurt you much more. Hitting a fifty-pound dog, at a speed of forty miles an hour, is equivalent to having a fifty-pound weight thrown with a velocity of sixty feet per second against your wheel.

Wheels are not made to indulge in such pastimes. Do not overwork your horn, and do not depend upon it entirely to give warning of what you intend to do. It is well to signal with the hand at crossings and corners when about to stop or turn. Do not confuse pedestrians whom you wish to pass, by a long series of blasts on the horn. They may bestrew themselves in your path in a way that will be very disconcerting, if not dangerous, whereas one sharp toot at the proper distance will cause them to seek a point of safety promptly. While on the subject of "Don'ts," the following by Mr. D. H. Morris are well worth fixing in the mind for general guidance in driving:

Don't disobey the rules of the road.

Remember to keep to the right and pass on the left.

Don't forget that pedestrians have the same rights as vehicles at street crossings.

Remember that vehicles do not have the right of way at street crossings.

Don't forget that your rate of speed should never exceed the legal rate, ten miles an hour in the greater city.

Remember, when local conditions require, to adopt even a lower rate of speed than the legal rate.

Don't get "rattled."

Remember that it is the "other fellow" who always loses his head in a crisis.

Don't insist upon your rights.

Remember that the "other fellow" may not know your rights, and an insistence on your part is bound to result in an accident.

Don't argue with trolley-cars, express-wagons, brewery-trucks, or other heavy bodies found in the public thoroughfare.

Remember that the drivers of these powerful vehicles generally operate on the theory that might is right.

Don't expect women and children to get out of your way.

Remember that women and children don't know how to avoid danger.

Don't run any unnecessary risks.

Remember that while the automobile is flexible, powerful, and easily controlled, you may make a slip.

Don't drink.

Remember that nine-tenths of the accidents occur to automobiles driven by intoxicated chauffeurs.

Don't sneak away in case of an accident.

Remember that the true gentleman chauffeur, although he may not be responsible for the misfortune, stands his ground.

Don't fail to be a gentleman under any provocation.

Remember that the Golden Rule practised in the road will save you no end of trouble, expense, and worry.

CHAPTER XI

HOW TO CARE FOR AN AUTOMOBILE

Enough has already been said in these pages to convince the automobilist not only that his car will require proper care, but also that its efficiency will depend very largely upon the intelligence and regularity with which a general oversight is exercised. Whether he is to attend the machine himself or to entrust it to competent hands, he must decide on purely personal grounds. If he is sufficiently fired with the enthusiasm of becoming an expert or even a reasonably competent automobilist, he will learn more by assuming all the routine care, except that involving mere drudgery, and he will depend upon the machinist when he gets "stuck." If he has any taste for mechanics, the work will then at least be done *con amore,* which is a rare luxury in the case of the hired attendant.

The object of care is of course to have the car always available to start at short notice and to give its maximum efficiency during the trip. Smartness of appearance is the pride of all but the slovenly driver, and the routine of external cleanliness will most commonly be entrusted to the intelligence of the hired man. Wise is he who has chosen an

automobile body of the simplest lines, without unnecessary corners and crevices, corrugations and convolutions, whose levers are as plain as the surgeon's forceps and whose casings present as smooth a surface as possible to the dirt of road travel. Builders are far too prone to turn out machines with unnecessary ornamentation. These look very smart in the show-room, but turn the stable into an arena for the labors of Hercules.

Smartness will demand frequency and regularity of cleaning, and varnish bills will depend somewhat upon the methods of cleaning allowed. If your man knows his business, he will employ nothing but water and chamois skin on the body and wheels. A little gasoline mixed with the water may be used when necessary to remove grease, but the surface should be oiled and polished afterward. After a run in bad weather the car should be hosed down to remove the mud before it dries. If you are breaking in your coachman, you will have to watch him for a while, till he evolves a system of hosing which will not splash the frame, soak the bearings, nor wet the motor at all.

Unless the machine is housed in a building absolutely free from damp, a waterproof covering reaching to the floor should be provided. In any case, the car should be covered from dust when not in use. If garage is not hired for the car, some coach-house or out-building will probably be adapted, which is easily done. The place should be well lighted, if you are to work about your car with

any comfort. If a pit can not be provided, a platform may be built to enable you to get at the car from beneath.

The mechanical care of the car involves a regular routine to be gone through every time a trip is contemplated. The careful driver will not be in such a hurry to get on the road that he will forget some important detail, the neglect of which may seriously hamper him in getting the car to its destination. It is doubtless very trite to be always telling the tyro not to try to run without gasoline, oil, and water, but the number of instances where cars have been stalled on the road for lack of one or more of these essentials seems to warrant their repetition. Have a systematic routine in preparing to start, and go through it religiously every time. The operations may be in some such order as this:

1. *Fill the Gasoline-tank.*—If you have ever had a gasoline-stove in the family, you will be familiar with the usual cautions about never filling near a light nor striking a light immediately after filling. Use 76° gasoline in winter. In summer you may use as low as 74°, but it is best to adopt a uniform grade and test each supply by means of the small hydrometer sold for this purpose. You will thus come to know the capabilities of your fuel under different conditions and be able to regulate it with more accuracy. Always strain the gasoline through the funnel. Funnels are provided with wire gauze for this purpose, but it is best to use thin chamois leather in addition,

as this will absolutely exclude any water. Water in the carbureter will result in loss of power and may keep you looking for the source of a breakdown a long time unless you happen to remember that you did not strain the fluid. If inlet to the tank is closed with a screw-cap, when you lose it do not replace it, even temporarily, with a cork. It will only take a minute particle of foreign substance to clog the needle-valve and cause an unaccountable stoppage. The author knows an experienced driver who went over all his car four times on a lonely road before he discovered that a mosquito had found sepulture in the valve and was effectually cutting off the supply of gasoline through the spray. It will prove a comfort if you have the lost screw-cap replaced eventually by a tap with large aperture protected with wire gauze. Before filling, make sure that the supply-valve to the carbureter is closed. If there is a filter in the carbureter supply-pipe, with a drain-tap, open this and draw off the collected impurities at least once a week.

II. *Examine the Carbureter and its Connections.*—See that the gasoline supply-pipe is free from obstruction and that all dirt is cleaned away from the air inlet. The point of the needle-valve must be kept bright and its seat true in the casting. Test the free working of the float by depressing the stem. Note working of throttle by moving lever on the steering-pillar or wheel.

III. *Fill the Water-tank.*—Use the cleanest

water you can get and do not use it any colder than you can help. You will have to fill the tank every time you start out, and if the run is long you may have to fill it before returning. If you have been compelled to use hard or dirty water on the road, drain it all out and refill before starting out again. In cold weather it is best to drain off the water every time the car is put up, even if you use a freezing mixture, unless the car is housed in a place where you are sure the temperature will not fall below 40° F. Various freezing mixtures are recommended by manufacturers, but as none of them are guaranteed it is not well to depend absolutely on them. Four pounds of calcium chloride to the gallon is said to prevent freezing down to 17° F. below zero. The solution should be strained before using. Two pounds of calcium chloride to the gallon, strained, and one pound of glycerin added per gallon is another formula.

In filling, open the drain-cocks from water-jacket and radiator, and pour water into the tank till it overflows, with the water escaping freely from the cocks. The object of this is to prevent air-lock in the circulation-pipes. An air-bubble in the bend of some pipe may effectually stop the water circulation, allowing the water in the jackets to boil away and the motor soon to overheat. If steam is detected escaping from the relief of the water system, look after the circulation at once by opening the cocks and seeing that the water runs free from them with the motor running. It is well to run the

motor for a few minutes before starting and then to judge of the condition of the circulation by feeling the upper and lower coils of the radiator to see if they are at the same temperature. You will soon come to know how long it takes for the circulation to heat up evenly, and you can be busying yourself with other preparations while it is doing so. Don't try to fill the gasoline-tank while the motor is running and don't start it till you have filled the water-tank, oiled all the motor bearings, and tested the ignition system.

IV. *Inspect Ignition System.*—Test the batteries by means of a voltmeter to see that they are giving sufficient voltage. Test each cell individually and see that it contains enough liquid. See that all terminals are tight in their binding-posts and that terminals are clean. Do not ruthlessly tighten the binding-screws of the coil, but gently insure a firm connection. Clean excessive acid corrosion from battery terminals with ammonia and a tooth-brush. Have the platinum points on the tremblers bright and clean and be sure the adjustment of the tremblers is right to give the proper flexibility of spring and the same musical " ping " as when received from the factory. Tremblers must be adjusted while motor is running at high speed, by holding down all but one, and turning the screw of this till the running of the motor is perceptibly improved. Repeat the operation with each spring in succession. Be sure the spark-plug is clean and sparking-points bright and at the right

distance apart, $\frac{1}{32}$ of an inch, or $\frac{1}{16}$, if your system has an external spark-gap. (See Fig. 120). The quickest way to detect dirt on the spark-plug, if there is no external gap, is to disconnect the high-tension terminal from the plug and, holding it very near its post, so as to cause a slight external spark, have some one crank the motor. If the motor will not start, the plug will have to be taken out and cleaned. If it does start, holding terminal by the insulation, let the motor get running, then switch off ignition, insert and bind terminal quickly, and switch on ignition. If you are not skilful about this, you will have to crank again, but if there is only a little dirt on the plug, it will be dried by this time, and the compressed gas will be hotter and more inflammable, so that the motor should start without trouble. If the source of current is a dynamo or magneto, of course see that all connections are clean, and that parts are in working order.


FIG. 120.—EXTERNAL SPARK-GAP FITTED TO BINDING-POST OF SPARK-PLUG.

V. *Inspect Valves.*—See that they are working freely as the motor is turned over with ignition circuit off. Test seating by turning the mushroom around, and noting any unevenness by the feel. If a valve is very dirty or burned badly, and you have any doubt about its seating, you had best test it for leakage as explained in another part of this chapter. Do not attempt to run with leaky

valves, or a stem that is badly weakened by the hot exhaust of the motor. Clean or change them before starting.

VI. *Lubricate.*—The instructions of manufacturers are very full and explicit as to the quantity and quality of lubricants to use on each part, and you had better follow them faithfully till experience suggests modifications. Go about the oiling in regular order, and make a point of inspecting each part whether you oil it or not. Go over them in some such way as this: (1) Open crank-case drain-cocks and draw off old oil if there has been any extensive running the previous trip. The case should be washed out with kerosene about every five hundred miles. (2) Close cocks and fill sight-feed reservoir. (3) Supply oil to crank-case by pouring in the necessary quantity, or by the necessary proper number of strokes of the force-pump if one is provided. Be sure that the pump gives full discharge. (4) Fill all motor oil-cups, not forgetting dynamo, magneto, pump, and fan. Don't use the gasoline funnel for pouring in oil. (5) After starting the motor, adjust the stroke of the oil-pump so as to give the proper feed. Too much oil will make itself manifest by a light-blue smoke in the exhaust. This should, of course, be remedied at once. You may better err at first by using too much oil than too little. If the car has not an automatic oiling system, do not forget, in running, how often you must supply fresh oil to the crank-case, and be sure to drain off the old oil

each time. The motor will require lubricant oftener when running continuously on the low gear. (6) Oil the clutch-leather. Give it all the oil it will absorb, if new. Aim to keep its surface like that of a razor-strop. Oil clutch-bearings. (7) Pour enough of the proper kind of oil into the change-speed gear-case to bring the level up to about the lower edge of the shafts. Several times a season the case should be drained, and washed out with kerosene. (8) Fill any oil-cups on the transmission-bearings. (9) Fill differential gear-case to proper level, usually about one-third full. Some differentials are packed in grease, which should last an entire season, but should be inspected regularly. (10) Oil the bevel-gears and see that there is enough grease on the universal joints of the shaft, if the car has this kind of drive. It is best to have the joints enclosed in a leather case packed with grease, as they are then better protected and require less attention. (11) See that there is enough grease in all grease-cups, beginning at the steering-knuckles and going right down the car to the rear brake-drums, giving each cup a slight screw down. (12) See that front and rear hubs, steering-gear case, and any other bearings packed in grease, are in good condition. (13) Oil steering-column, steering-rod joints, reverse-chain, spring-hangers, brake-levers, and joints, and any other moving parts not provided with cups. (14) Oil steering-wheel bearings, all hand-levers, and other friction points in the dash equipment. Be careful in lubricating

not to get any oil on the wire terminals of your ignition system, and in general refrain from dropping oil around where it is not needed.

As you are going over the lubrication of the car, keep a lookout for any loose bearings, and be sure to take them up. Accustom yourself to trying all bolts and nuts to see if they are tight. Work all levers to make sure that they move free. Be particular to test the brakes and see that they do not bind or drag when thrown off. Belts and chains should be seen to and any undue slack taken up.

Try the clutch and see whether it needs adjustment of its spring. If you learn to know the normal feel of the car, by pushing it a short distance over the floor of the motor-house, with brakes off and clutch disengaged, you will have a pretty fair test for making sure that there is no unusual resistance to rolling, and that nothing has been forgotten in the way of lubrication.

VII. *Pump up Tires.*—Tires should be kept pumped up hard at all times if the car is in constant use, and this should be attended to, if necessary, before putting the car up as well as at starting out. Tires must be kept dry and free from any oil or grease, which may be removed with benzine. Wipe them carefully after a run and inspect carefully, before starting, for cuts and chips, and for proper seating in the rim. Unfortunately most tire repairs have to be performed on the road, but if incipient cracks and crevices be first scraped clean and then

filled carefully with thick rubber cement before taking the car out again, the labor will be appreciably rewarded.

VIII. *See that all Tools and Supplies are in Place on Car.*—The kit furnished with the car is never complete and will very soon have to be added to if you wish to drive over an appreciable radius in comfort. It is best to have a place on the car for all tools liable to be needed in ordinary running, and to return them to their place after using them in the motor-house. Here is a sample list of tools furnished by the makers:

1 funnel.
1 brush for cleaning spark-plug.
1 B. & S. 6-inch combination wrench.
1 pair of 6-inch improved pliers.
1 6-inch cold-chisel with ½-inch face.
1 large screw-driver.
1 ¾-ball peen-hammer.
1 8-inch file.
1 oil-can.
1 double-end spanner-wrench for removing hub-caps and rear axle inside adjusting-nuts.
1 complete tire-repair kit.
1 foot-pump.
2 extra spark-plugs.
1 book of instructions.
1 canvas tool-case.

With additions to these you will find the list grow to something like the following array of almost indispensable savers of time and temper:

Flat cutting-pliers.
Hand-vise, 1½ inches across.
A screw-spanner.

A very short screw-driver.
A penknife.
A duster, or wiping-cloth.
1-lb. hammer.
Three steel and iron punches.
A key-driver, or extractor.
A short copper bar, or punch.
Cold-chisel.
10-inch screw-driver.
6-inch flat file.
6-inch half-round file.
6-inch triangular file.
6-inch small round file.
Set of box-spanners.
An oiler.
A grease-pump.
A densimeter.

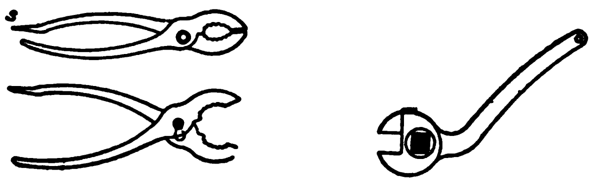
TIRE TOOLS:
Jack.
Air-pump with gauge.
Three tire-removers.
Repair-kit box.
Containing:
Scissors.
Glass paper and scratch-brush.
Tube of solution.
1 doz. small patches.
1 doz. large patches.
Thread canvas.
Two tire-bands (extra cost).
Two gaiters and laces (extra cost).
Gaiter-pads (rubber).
French chalk, ½ lb.
Spare tire-clip.
Valve-tubes, valve-nuts.

STORES, ETC.:
A canvas pail.
A large funnel or spout to fit gasoline-tins.
Some thin, strong rope.
Extra tin of gasoline.
One tin of oil (bearings).

One tin of oil (crank-case).
One tin, empty.
One roll of pure rubber tape.
One tin of grease.
Iron wire.
Steel wire.
Copper wire, and a little sheet and small tubes (tinned).
Asbestos card, and ditto string.
Asbestos joints, ready cut; asbestos and copper spark-plug washers.
Washers, nuts, screws, studs.
Box containing needles, fine hook-needle, split-pins, broach or needle-holder.
Fine emery-cloth.
Valve grinding-tool.
Small tin of paste of fine emery and oil.

Keep the tire tools and kit all together in some part of the car that is cool, and can be got at quickly without disturbing any one.

Make a group of the tools required most frequently and keep them instantly accessible, rolled in



I. II.

FIG. 121.—DOUBLE-GRIP PLIERS (I) AND SMALL SCREW-SPANNER OR WRENCH (II).

a canvas kit. First among these come the (1) *pliers,* which should be of the double-grip variety, with screw-driver end. (See Fig. 121.) You will be wanting these in innumerable little emergencies, such as unscrewing tank-caps, pulling out and putting in split-pins, straightening and cutting wire,

holding some nut or bolt too hot for the fingers, and tightening nuts not so stiff as to require the spanner. In tightening, the nut must be gripped firmly, so as not to materially damage its corners. The screw-driver end will be found useful in removing screw-bungs and in various adjustments where the (2) *short screw-driver* is unnecessary. The latter will be useful to reach parts otherwise inaccessible from proximity to portions of the car and mechanism not readily removed. The (3) *small pliers* will be frequently needed to hold some part upon which you are working with the large pair, such as twisting wire, keeping a bolt still while the nut is tightened, etc. A (4) *small screw-wrench* will be often a time-saver, and a (5) *penknife* will be indispensable. Don't trust to your pocket-knife, but have one provided for the car, and replace it when it gets broken, as it frequently will. Have it cheap enough and strong enough to use for anything. It will cut the insulation from the end of a wire, scrape the wire clean, cut asbestos joints, cut a piece of hose for the water system, and even pry up a stuck washer. The (6) *small hand-vise* belongs in this "first-aid" kit and also the (7) *dust-cloth,* which you will want constantly for wiping your hands and holding hot things, besides for its legitimate purpose.

Under the tonneau seat, or beneath the above kit, you can keep in a leather bag the tools needed for more serious repairs and adjustments. The (1) *hammer,* (2) *cold-chisel,* and (3) *blunt punch*

belong here. The pliers and monkey-wrench will not take the place of a good hammer with one thin, flat head, and the other thick and round. The handle should be about ten inches long. There are innumerable ways in which it will be useful. You can use it as an anvil, shape a piece of tube with it, or take up the blow with it when tapping on the other end of a shaft. With the blunt punch it will budge a nut that will yield to no other persuasion, and with a fine punch it will be efficacious for a refractory rivet. With punch and hammer you can mark a small part for replacement in the right position by striking a dot or two on it at the proper point. With the cold-chisel you can cut away a useless projection that makes a bolt inaccessible, you can cut a bit off the spring of a valve to secure better working, you can wedge off a tight washer-ring or bolt by tapping in the chisel. A hard (4) *copper rod* interposed will permit you to hammer around a nut without damaging it, to hit a bolt on the threaded end to get it out safely, and even to hammer on cast iron with less chance of breaking it. The (5) *large screw-driver* will hardly be needed in the emergency kit, as the screws in the mechanism are usually few and small. An excellent practise of some makers is to have all bolts notched in the head, so that they can be held by the screw-driver while a nut is being put on, or the bolt can be turned into the nut till tight enough for the spanner. With cold-chisel or hack-saw you can make such notches at the repair-bench when re-

pairing at home. Be careful not to get the notches too deep, weakening the bolt. Discrimination must be used in the employment of (6) *files*. They are chiefly of service in adjusting spare parts. Use them as little as possible on parts to be reassembled. They are good to cut steel wire, to ease a screw-thread which is too full, or has been accidentally hammered, to fit rivets, and to open out round holes. The files should all be fairly fine, except the half-round one, which may be coarse, since it is only used in preparatory work for the flat file. Perhaps the most important members of this group

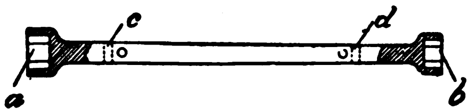


FIG. 122.—BOX-SPANNER WHICH CAN BE MADE BY ANY BLACKSMITH.

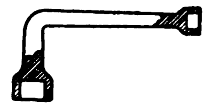


FIG. 123.—CURVED BOX-SPANNER WHICH A BLACKSMITH CAN MAKE.

are the (7) *box-spanners,* since those provided by the manufacturer do not always fit every emergency. When you have to call upon your friend the repair-man for some adjustment, observe whether he uses your spanner or his own. If he has trouble with yours, get him to forge you a set which should include several long, straight ones, to take a different-size nut at each end (*a* and *b*, Fig. 122), and with a hole at each end (*c* and *d*) for the bar. Another useful shape for getting at nuts which can not be reached by long spanner is shown in Fig. 123. The ideal box-spanner is made of steel tubing, but the local blacksmith will not make as

good a job of this as the solid forging. Special spanners of different kinds may be bought, one of the most ingenious being that with universal joint and changeable boxes, as shown in Fig. 124.

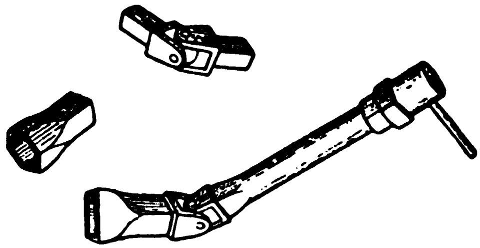


FIG. 124.—SPECIAL BOX-SPANNER.

Include in this group (8) the *key-driver,* some (9) *tool-steel,* a pencil-case, full of (10) *fine needles,* to clean out carbureter needle-valve and spray-holes. A very useful combination of case and holder for these is shown in Fig. 125.

Spare or duplicate parts form an important section of your driving equipment. Provide a box in which to carry one duplicate of every kind of bolt and nut used on the car. This will not take up much room, and the satisfaction derived from it

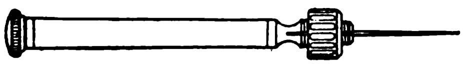


FIG. 125.—CASE AND HOLDER FOR NEEDLES.

will be infinite in case of a nut working off or being lost during some adjustment on the road. Nuts that have not a special locking device must be frequently examined, for the constant vibration of

the car has an almost miraculous power in working things off unexpectedly. Various methods of locking nuts are shown in Fig. 126. The most important nuts to lock, which should be done on all cars when sent out by the makers, are (1) all nuts in steering-gear; (2) all nuts at both ends of connecting-rods; (3) all nuts holding on the wheels. A few points to remember about bolts and nuts are as follows; you will pick up others by intimate acquaintance with the repair man:

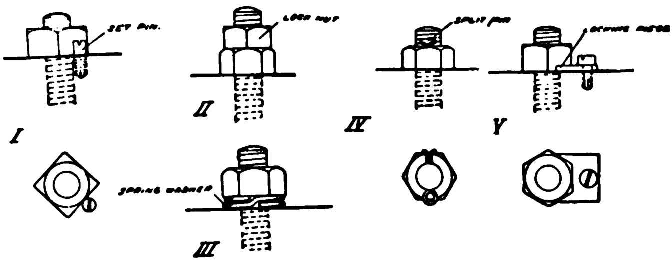


FIG. 126.—METHODS OF LOCKING NUTS.

When a joint is held by a number of bolts or screws, tighten by degrees, beginning with those opposite each other, going round and round till all are equally tight.

When dismantling, put nuts on their own bolts; put all bolts, nuts, screws, washers, and pins belonging to any one piece into one receptacle. When repairing, be liberal with extra washers, lock-nuts, etc., where they are needed. Makers do not always provide these sufficiently. In screwing or bolting two parts together "dead tight," you will make

a better job with less trouble by introducing a washer.

Oil and clean every screw before tightening it.

Do not exert the full force of a spanner whose handle is longer than six inches on a bolt three-eighths inch or smaller. If you can not budge the nut, oil it with a mixture of gasoline and paraffin and wait half an hour.

If an iron bolt breaks, replace if possible with a mild steel bolt of same caliber or a larger iron one.

If a stud comes loose, tighten it (1), if you can get at the thread, by lock-nutting two nuts on it and then turning these with a spanner; if not (2), make a saw-cut in the head and drive it in with a screw-driver; or (3) use pliers on part not threaded or where thread is not used. Same methods may be used in extracting a half-broken stud, unless it is too short, when it must be drilled out.

The automobilist should use whatever influence he has to secure the standardization of bolts, nuts, and screw-threads by makers on all cars.

A spare ignition battery should always be carried, fully charged, in position where it can be switched on, if the car provides for this; if not, in some part of the tonneau. It is a good plan to always charge accumulators fully before starting out if an electric-light circuit is convenient, as the cells last longer when so treated.

Carry several extra spark-plugs, several spare

platinum-tipped screws, for tremblers or contact-breaker; two or three yards of the best insulated copper wire, as well as a complete set of ignition connections, with terminals. Carry one duplicate of every asbestos or rubber joint, ready cut.

Extra valves must not be forgotten, likewise several chain-links, a dozen lamp-wicks, an extra tin of calcium carbide, and a tin of paraffin-oil.

When a fairly long trip is contemplated, it is highly advisable to carry a tin of gasoline in case of being stalled, for want of that precious liquid, in some spot where you would pay any price for enough to get you to the nearest town.

Likewise it is best to carry one cover and two inside tubes for each size of tire on the car. This will make six tires the regular equipment of the car, and when one is damaged seriously it can be sent off for repairs without crippling the vehicle.

Enough has already been done in the way of enumeration to fill the mind of the inexperienced motorist with pictures of himself spending the remainder of his life either in the motor-house or on the road, making repairs, with occasional intermissions for meals and a little riding to see if his adjustments are correct. Such is far from actual experience. It must needs be that breakdowns come, and happy is the driver who has aboard the "one thing needful." There will be, with a reasonably good car, plenty of running to satisfy even the somewhat extravagant demands of the begin-

ner. Care does not consist in always tinkering with the mechanism, but when adjustments have to be made, the desideratum is to get them over in a shipshape manner, before the exhilaration of smooth running has dissolved into the gloom of a long wait.

In the preceding chapter, it was pointed out that the driver must become so much in touch with his car that the normal hum of the machinery is constantly in his ears, so that he may detect instantly any departure from this. Unusual noises must always be taken as a warning that care and possibly adjustment are required. They call for the exercise of the preventive ingenuity that marks the skilful automobilist.

The noises you will come to distinguish in time are:

I. "*Knocking.*"—This invariably indicates that something is out of kilter. It may be due to some fault of the ignition. Be sure the spark is not advanced when the motor is not running at a correspondingly high speed. If it is advanced, the charge will give its full explosion-pressure during the compression-stroke, and the strain may be sufficient to bend the connecting-rod.

A peculiar knock, much sharper than the foregoing, occurs if the ignition-plug is so placed that the spark occurs in the absolute center of the combustion space for any position of the piston. This knock will occur only when the lever is at one particular point; a slight advance or retard will

prevent it, but the lever is not available in this position. The remedy is to fit another kind of plug which enters farther or not so far into the cylinder. The cause of this knock is probably some imperfectly understood molecular condition. It may not always occur with the central spark, and it may possibly occur with a spark that is not central. When knocking is caused in this way, the only remedy is to experiment with different plugs until the right one is found.

Knocking may be due to either of the connecting-rod bearings working loose. The sound will occur at the beginning of each piston stroke.

The crank-shaft may have worked out of alignment with the connecting-rod, so that a side-thrust is given to it and the fly-wheel, causing them to knock against the crank-case bearing at each revolution. Packing behind one of the crank-case brasses must be introduced to true up the shaft.

It is possible that the crank-pin is bent out of true with the connecting-rod. This would cause a knock of the rod against the crank-pin bearings similar to the foregoing. It is hard to make sure of this condition, but if no other seems to be present, it is well to experiment with a little packing till mechanical diagnosis can be had.

II. *"Barking," or Explosions in the Muffler.*—These are easily recognized and are due to unburnt or partially burnt gases, usually of a previous misfire, being ignited in the muffler by the next accession of hot exhaust-gas.

The lift of the exhaust-valve may be advanced too far, so that the exhaust enters the muffler at too high a temperature and pressure, or the mixture may be too rich, containing enough unburnt hydrocarbons to ignite in the air of the muffler. Practise running with as little gasoline as will give full power, till you learn the point giving greatest efficiency with least noise.

Explosions in the silencer may be caused by a retarding of the ignition so far that it is not complete when the exhaust-valve has opened. This will soon result in a broken valve or stem.

Governing by lifting and holding open the exhaust-valve is a fruitful source of silencer explosions.

III. *Misfire.*—The most common cause of such noises is the escape of unburnt gases due to a previous misfire. You will learn to detect by ear a misfire in any of the cylinders. It may be due to some trouble with the ignition system. Suspect a weak or exhausted battery and test with your voltmeter, which should not read less than 3.4. Switch over to your spare battery, and if this does not cure it, suspect a loose connection in the circuit. If you are on the road and have a spare set of wires, it may be quickest to connect these up at once, making sure that each post binds well on the platinum tips. If this fails, there may be a breakdown in the coil, or an intermittent leakage over the high-tension wire, varying as it is swung by the motion of the car. Usually, in the above cases,

the misfire occurs whenever the car is jolted. If you can not get at the trouble, you will have to drive carefully till you get home and then give the ignition a thorough overhauling.

If the misfire occurs when the spark is advanced, the spark-plug points may be too far apart; or the "make" of the primary circuit may be too short previous to breaking; or the trembler does not vibrate fast enough; or there may be oil and dirt on the contact-breaker, causing too slow a "break."

Misfires may be due to flooding of the carbureter caused by jolting. Admit more air, if apparatus provides for this. There may be water in the carbureter, due to condensation from cold. Look after the temperature of the carbureter, especially in freezing weather.

A broken admission-valve spring or a bit of dirt in some supply-pipe are not uncommon causes of misfires.

IV. *Hissing.*—This is generally due to leakage during compression. First test the joint between spark-plug and cylinder by squirting a little paraffin around it and having some one crank the motor against compression (*with the ignition disconnected*) while you watch for bubbles. If there are any joints in the cylinder-head, treat them in the same way. If these joints show no leakage, clean the valves. If these do not then fit perfectly, they should be ground (see VI). If the leak is in neither joints nor valves, look after the piston-rings. Be sure that the notches of the rings are not in line.

(See Fig. 127.) If they are, turn them so that they will be as far from each other as possible.

The cylinder wall may be scored and scratched through neglect of lubrication or from dirt getting in. The cylinder will then have to be ground and new rings fitted. These should be slipped to their grooves over two or three pieces of thin, smooth cardboard, placed at intervals against the side of the piston. The slipping must be done very evenly and patiently, so as not to break the rings. When fitting new rings, rub red lead, mixed with oil, over the entire piston-sweep of the cylinder wall and insert the piston with its new rings. Draw out the piston and file down (a very little at a time) the parts of the rings which rub hardest as shown by the red lead. Finish the adjustment by rubbing with emery-paper.

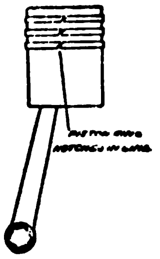


Fig. 127.—Incorrect Position for Piston-Rings.

V. *Sharp Spitting or Cracking.*—This occurs when there is a leakage during the explosion-stroke due to loose piston-rings or valves. Test your cylinders frequently for compression by means of one of the small pressure-gauges made to screw into the aperture for the spark-plug.

VI. *The Slight Snap of the Inlet Valve.*—This sound indicates that the valve is working properly. Its absence reveals the fact that the valve is stuck, or for some other reason does not close. If your inlet valve is atmospherically actuated, you may

carry an extra valve with seat and spring complete. In case of trouble you can then screw in the spare and determine at once if the old valve was at fault, leaving it to be adjusted at home.

To test a valve for leakage, fill the recess *R* (Fig. 128) with gasoline. If this leaks out at the face of the valve *F*, the seat is not true. To grind the valve, you must rotate it on its seat with a screw-driver, introducing between the mushroom and the seat a thin paste of fine pumice and oil, paraffin, or gasoline. If the valve is ground on the cylinder, plug the entrance below it with waste, so as to prevent any paste getting into the cylinder, and clean up carefully before removing the plug. To avoid grinding rings in the surfaces, lift the valve between turns. An Archimedean screw-driver or a bit-brace will make the process less tedious. If you do much valve-grinding, a small lathe will be a handy addition to your tool-bench.

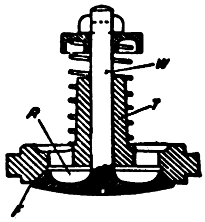


Fig. 128.—Automatic Inlet Valve and Seat.

Be careful about the lubrication of the tube, *T*, or your valve will stick. If you suspect this, wash out tube and valve-seat with gasoline. Do not use bad oil or too much oil on the valves.

The valve-spring may be too weak or too strong. New springs are furnished a little too long, so that they may be cut down and adjusted by trial and error, till the valve shuts properly. The travel of

the valve must not be so far that it can not return in time, hence the space, *E*, between the tube, *T*, and the washer must not be too great.

VII. *The Whir* if the motor begins to race.

VIII. *The Squeak of any Bearing not Properly Lubricated.*—At starting, see that there is plenty of oil in the tank, and that the drop-rate in the sight-feeds is correct. Time the drops carefully after engine and lubricators are warm. Four drops a minute is about right, but the makers of the car furnish directions on this point. Give each grease-cup about one-eighth turn on starting out. If you are obliged to use oil temporarily on a bearing previously lubricated with grease, see that the oil flows through, and is not cut off by grease in the pipe. It is best to wipe the grease off a bearing before using oil on it.

IX. *Rattle.*—This indicates that some part is working loose, and, because of the importance of its detection, no oil-can, tool, spare, brake-band, mud-guard, or other part, should be allowed to shake around loose on the car.

X. *The Thud* of a deflated tire.

XI. *The Stoppage of the Water-pump.*—This, of course, is an absence of normal sound. If the water-pump is chain-driven, the stoppage of the chain will, in all probability, first be noticed.

A still higher form of divination, the esoterics of which will eventually be mastered by the driver, is the "feel" of the car. He will differentiate the

throb of the motor and the minute vibration of the gears from the jumping and swinging caused by the road surface, so as to instantly get the "feel" of (1) a chipped gear-wheel, (2) a weak carriage-spring, (3) back-lash in steering-gear, (4) a jumping chain, (5) a flat tire.

Remedial measures for (1) and (2) must be deferred till the car is off the road. Loose chains may be taken up by tightening the chain adjustment-nuts, or by taking out one link, if necessary; be careful, however, not to get the chains too tight, as they then consume too much power. See that the master-link which fastens the ends of the chain is secure. If one link is wearing faster than the others, replace it with a new one. This, of course, is not necessarily a road adjustment; a link loose in its rivets, or catching on the sprocket-teeth, unfortunately is. Be particularly careful about chain adjustments, as breakage on a hill or elsewhere may render the brake ineffectual.

The steering-gear is usually provided with means of taking up wear.

The subject of tires is one upon which a whole book might be written, and several excellent handbooks are issued by makers, containing valuable hints in addition to special instructions for their own tires. Have tires of ample size for the weight of your vehicle. If such are not provided with your car in the first instance, you will soon have an opportunity to replace them, since relatively large tires decrease wear and increase easy

running. If you are willing to sacrifice something of the latter in the interests of economy, you may use mixed tires, placing the solid or cushioned variety on the rear wheels. If the wheels are not parallel when running straight ahead, or if they are too nearly parallel in turning, or if the differential gear is not properly lubricated, or if there is a bent axle, the wear on the treads is excessive. Hence, keep running-gear always properly adjusted.

Tires should be stored in a dark, cool, and, above all, dry place, where no oil can possibly get at them. They should be wrapped in canvas or paper, the inner tubes very loosely inflated, just enough to prevent kinks. When tubes are carried in the car, they should be loosely folded in a rubber bag, plentifully supplied with chalk. No weight should be allowed to press upon them. If the system of carrying two complete spare tires is adopted, a special compartment may be arranged in the body. This system will render road repairs rather infrequent and save much annoyance, since it is easier to change a tube or a cover on the road, than to mend a puncture.

The size of tires required depends upon the weight of the car and the power of the motor. The following table, based upon careful experiments by Michelin et Cie., shows the sizes of their tires required for various powers and weights of cars. It may be taken as fairly typical of general requirements:

Size of the Tire.	Maximum Weight Borne by the Axle.	Maximum Power of the Motor for the Driving-wheels.
65 mm.	1,210 lbs.	7 H.P.
90 "	1,980 "	12 "
105 " light.	2,090 "	14 "
105 " extra strong.	2,200 "	18 "
120 "	2,640 "	Over 18 "
65 " light.	440 "	
65 " reenforced.	750 "	For front wheels only.
75 " light.	580 "	
75 " reenforced.	750 "	4 H.P.
75 " extra strong.	970 "	6 "
85 " light.	620 "	For front wheels only.
85 " reenforced.	970 "	5 H.P.
85 " extra strong.	1,320 "	9 "

The car may be weighed upon any platform-scales, such as those of the coal-dealer. Have all fittings and accessories in the car, all seats occupied, all tanks full, and the equivalent of all luggage liable to be carried at any time. Run the car on to the platform and weigh it as a whole. Then weigh the rear part by running the forward wheels off, so that the middle of the step is over the end of the platform. Back the car till the same point is over the other end of the platform, and weigh the front part of the car. The two latter weights should total up to the first weight, with allowance, of say twenty or twenty-five pounds, for error, if the weighing has been done correctly.

The degree of inflation bears a direct relation to the weight that tires have to carry, as indicated in the following table by Michelin, who states that when the car is loaded the tire should flatten about $\frac{2}{5}$ of an inch and never more than $\frac{3}{5}$.

The amount of flattening can be roughly judged

Thickness of Tire.	Reenforced Car or Voiturette Tires.			Reenforced Voiturette Tires.			Light Voiturette Tires.		
	Maximum weight the tire can bear.	When the tire carries.	The following pressure is required, per sq. inch.	Maximum weight the tire can bear.	When the tire carries.	The following pressure is required, per sq. inch.	Maximum weight the tire can bear.	When the tire carries.	The following pressure is required, per sq. inch.
65 mm.	600 lbs.	340 to 400 lbs. 440 to 600 lbs.	50 lbs. 64 lbs.	375 lbs.	220 to 300 lbs. 300 to 375 lbs.	35½ lbs. 42⅔ lbs.	220 lbs.	110 to 175 lbs. 175 to 220 lbs.	28½ lbs. 35½ lbs.
75 and 80	480 lbs.	330 to 440 lbs. 440 to 480 lbs.	50 lbs. 57 lbs.	375 lbs.	220 to 300 lbs. 300 to 375 lbs.	35½ lbs. 42⅔ lbs.	260 lbs.	110 to 175 lbs. 175 to 260 lbs.	28½ lbs. 35½ lbs.
85 mm.	660 lbs.	440 to 550 lbs. 550 to 660 lbs.	71 lbs. 64 lbs.	480 lbs.	330 to 390 lbs. 390 to 480 lbs.	42⅔ lbs. 50 lbs.	300 lbs.	130 to 220 lbs. 220 to 300 lbs.	35½ lbs. 42⅔ lbs.
90 mm.	990 lbs.	550 to 770 lbs. 770 to 990 lbs.	57 to 71 lbs. 71 to 78 lbs.						
105 mm.	1,140 lbs.	660 to 990 lbs. 990 to 1,140 lbs.	57 to 71 lbs. 71 to 78 lbs.						
120 mm.	1,320 lbs.	880 to 1,100 lbs. 1,100 to 1,320 lbs.	64 to 71 lbs. 71 to 78 lbs.						
150 mm.	1,650 lbs.	1,100 to 1,430 lbs. 1,430 to 1,650 lbs.	71 lbs. 85 lbs.						

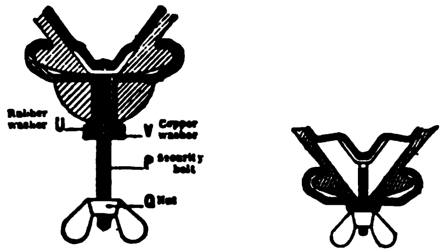
by measuring the track of the tire, which should not exceed an inch and a half for 65 mm. tires; two inches and a half for 80 mm. and 90 mm. tires, and three inches and a quarter for 120 mm. tires. The most accurate way, and really the only satisfactory one, for keeping the tires inflated to the proper extent, is to use a pump with gauge showing the air-pressure obtained in the tire. In pumping, give full strokes, evenly and not too fast; stop on a down-stroke and hold the pump, when hand of gauge will slowly go down to a point where it stops; this indicates the true pressure. If it is not sufficient, repeat the process and make sure that the gauge-hand not only ceases to oscillate, but falls to position of rest before taking the final reading. The tyro is usually afraid of inflating the tire too much, and as a rule, therefore, fails to inflate them enough. When tires are new, they should be inflated frequently, as the cover only attains its final volume with use. The use of the guage makes it easy to maintain just the requisite pressure. After a couple of weeks of running, the pressure may be approximately judged by feeling the tire and examining the track. Unless there is a leaky valve or a puncture, it will hardly be necessary to inflate more than once a fortnight, when the pressure can be accurately adjusted by gauge. If the car is only taken out two or three times a month, it is well to provide wooden wedges for each axle, so that the weight of the standing car will be removed from the tires. If the car is to be laid up for any length

of time, in addition to wedging up the wheels, the tires should be deflated until only sufficient air remains for the tubes to retain their shape. If the car is not to be used for several months, tires should be taken off, examined carefully, sent out for repairs, if necessary, or wrapped up and placed away. Rims should be carefully inspected, especially as to their edges, which should be straightened if necessary, and any sharp portions rounded off with a file. Rust on metal rims should be carefully guarded against by cleaning with emery-paper, after which two coats of ceruse and one of varnish may be applied.

The liberal use of French chalk will make tire-fitting much easier, as well as prolong the life of the tire, by lubricating the necessary friction of the inner tube against the cover. Caution is, however, necessary not to allow accumulations of the chalk within the tire, as these get compressed and work through the tread, thereby loosening it. Several pounds of chalk should be kept in a box in the motor-house. Preparatory to fitting in an air-tube, roll it round and round in the chalk until each part has been through it, then shake the tube thoroughly to remove the excess. When fitting on the road, shake into the cover some French chalk, turn the wheel around slowly several times, patting the exterior of the cover, then hold cover open at lowest point, and throw out, carefully, superfluous chalk. If the inside of the cover is suspected of being damp, you will have to be content with

spreading chalk on the air-tube by means of a clean rag, till the surface is uniformly soft and slippery. Never *wash* chalk from inside of cover with water, but brush it out with a dry brush and remove any obstinate particles with wood-alcohol.

Whatever else the automobilist learns, he must become expert in removing and attaching covers and tubes on the road, and in repairing punctures in both. As the latter operation involves the former, both may be described together. In the case of a puncture: (1) Jack the wheel well clear of the



I. II.

FIG. 129.—POSITIONS AND PARTS OF TIRE SECURITY-BOLTS.
I. Normal position, nut unscrewed. II. Bolt pushed into tire.

ground. (2) Turn the wheel round slowly till puncture is located, remove the offending object if it is present, and mark the place on the tire with chalk. (3) If the mud-guard impedes your movements, it will save time to remove it. (4) Remove all external parts of the valve, deflating the tire in the process. (5) Unscrew the wing-nuts to the ends of the bolts without removing the nuts. (6) Push each security-bolt toward the inside of the tire till the nut touches the rim; this will free all bolts which might

possibly stick to the cover. (See Fig. 129.) The next operation is (7) freeing the outer (farthest from the car) beading of the cover from the rim. Levers of different designs are furnished by

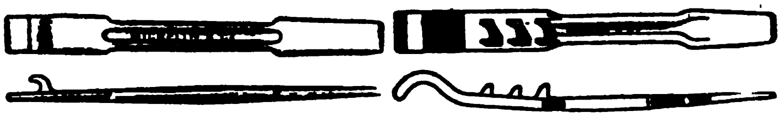


FIG. 130.—TWO KINDS OF TIRE-LEVERS.

makers (see Fig. 130), the principle of operation being very much the same in all cases. The best plan is to use two levers, or even more, inserting them a fairly good distance apart. Lubricate the points with French chalk. Grasp the top of the cover at a point between two bolts, being careful to avoid the place where the valve enters the tire. Holding the top, press with the palm against the side of the cover, and work the lever in slowly until it is in the position shown in Fig. 131. Lower the

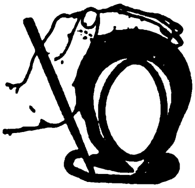


FIG. 131.—FIRST POSITION FOR INSERTING LEVER TO REMOVE OUTER COVER.

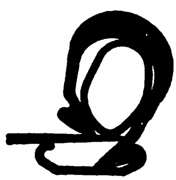


FIG. 132.—SECOND POSITION OF LEVER IN REMOVING COVER.

lever and carefully work it in until it reaches the opposite side, as shown in Fig. 132, using both hands if necessary; or, use two levers at the same point, until one has reached the opposite edge.

Care must be exercised that the tube is not nipped by the lever or jammed against the rim. Insert the second lever in the same way. Then, taking a lever in either hand, as shown in Fig. 133, bring them downward together, when the bead should slip over the rim, as shown in Fig. 134. If it does not, there is too much space between the levers. Bring them closer together and try again. If the beading slips back again as fast as it is pried out,

Fig. 133.—First Position of Levers in Removing Cover.

Fig. 134.—Second Position of Levers in Removing Cover.

then there is not enough space between the levers. If the bead comes out correctly, pull out one of the levers, being careful to hold it in the position shown in Fig. 134, and insert it about six inches beyond the other lever, lowering it as before, prying over a fresh portion of the bead, when the lever that was left in will drop to the ground. Go round the tire in this way until the edge is all over the rim.

To (8) remove the air-tube, take hold of the free edge of the cover opposite the valve, with the fingers extended inside the cover, holding it open; pull out the air-tube gently with the other hand,

going round the whole length of the tire. If the tube sticks to the cover, hold it very close and pull carefully, working in both directions toward the air-valve till the tube is all out except at this point. Holding the tube, insert the forked

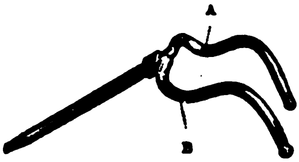


Fig. 135.—The Forked Lever.

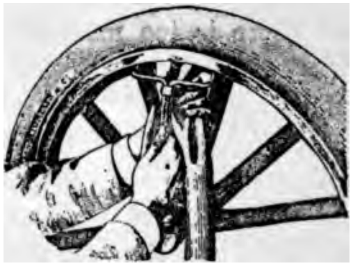


Fig. 136.—Manner of Using Forked Lever to Remove Inner Tube.

lever (Fig. 135), as shown in Fig. 136, until the bead is supported by points *A* and *B* of the lever. Lower the lever, as shown in Fig. 136, until the points roll into the rim. Reach in, with the other hand, and lift the valve from the rim, when the tube will be finally detached and should come free.

You should now carefully examine the inside of the cover to make sure that the object which caused the puncture has not worked through; pass the hand all around the inside, feeling for any projections or roughness. If you have an extra tube, the simplest way will be now to insert it in the manner shortly to be described; that is, provided cover can be patched without removing it from the rim, and reenforced by lacing on one

of the temporary bands for this purpose. (See Fig. 137.)

If it is necessary to repair the air-tube on the road, and you are not sure of the location of the puncture, it will be necessary to slightly inflate the tube; and if you then can not discover where air is escaping, you will have to fill your canvas bucket with soapy water, immerse various parts of the tube, and look for bubbles. When a puncture is found, mark it, deflate and dry the tube. Choose a patch to cover the damaged place to the distance of an inch or more all around; spread the tube on a clean, flat surface, and rub the area where patch is to be applied with a file-card until the surface is quite rough and clean. Spread solution on tube and on side of patch to be applied, waiting usually about

FIG. 137.—TEMPORARY BAND LACED OVER COVER TO PROTECT WEAK SPOT.

ten minutes, or until both have dried to the point where your fingers will adhere firmly when pressed against them. Then press patch firmly on, seeing that edges adhere properly. It is even better to apply two patches, one above the other, the outer

one being of somewhat thicker rubber, and to give the surface of the tube and the surfaces of the inner patch two or even three coatings of solution, allowing each to dry before applying the next.

Replacing the air-tube requires more care than removing it, and the operation must not be hurried. Begin at the valve. Insert a forked lever so that the valve-hole will be exactly between its two branches. Holding the air-tube with the other hand, as shown in Fig. 138, bring down lever to position shown in Fig. 136, and introduce the valve into

FIG. 138.—MANNER OF INSERTING TUBE BY MEANS OF THE FORKED LEVER.

the hole, inserting the portion of the tube around the valve under the bead. Let the bead gently down, and take out lever while drawing the cover toward you with the hand. Place the air-tube evenly round the cover, lifting the free edge of the cover with one hand, holding the tube at the top between thumb and fingers, pushing it well down inside the cover, working in both directions from the valve at intervals of about ten inches.

Be careful not to stretch the tube, but draw gently from the portion already in place. The deflated tube will seem too large for the cover, and it may

I. II. III.

Fig. 139.—Three Ways in which the Tube may get Nipped.
I. Between the bead and the rim. II. Between the bead and the bolt. III. Between the bead and the valve.

be necessary to fold it loosely in some places, in order to get it in. Be sure that it is not twisted or bunched in one part and stretched in another. Having got the tube in all around, screw on the valve connections and inflate very slightly. Slip the hand between rim and tube to place it evenly and to smooth out any creases that may exist.

The chief danger that now confronts you is

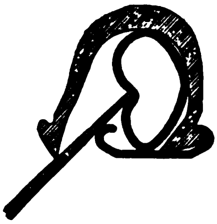


Fig. 140.—Wrong Position of Lever in Replacing Cover.

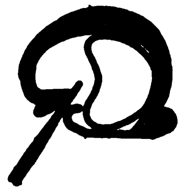


Fig. 141.—First Position of Lever in Replacing Cover.

nipping the tube between the edge of the cover and the rim, or the bolt. Fig. 139 shows three different ways in which the tube may get nipped.

This is sure to cause an irreparable burst sooner or later. To get the beading back in the rim, insert a lever about an inch over the rim. Do not get it in too far, as shown in Fig. 140, or it will be certain to nip the tube. The lever should

Fig. 142.—Final Position of Levers in Replacing Cover.

Fig. 143.—Wrong Position of Bead in Replacing Cover.

just rest upon the edge of the rim, so that it can be lifted into the position shown in Fig. 141. Begin with one lever about four inches on one side of the valve, then, holding it in position, with one hand introduce the second lever the same distance on the other side of the valve, lifting it when you have it in, bringing the eight inches of beading between the levers into the position shown in Fig. 142. When you have done so, remove one lever and, still holding the other, of course changing hands, insert the free lever as before and lift it to bring another portion of the bead in place. Fit the edge all around, working from both sides of the valve. When about two or three feet are fitted, push back the valve into the tire, at the same time pressing with the thin side of the lever upon the bead, so as to force it into the clinch of the rim near the valve. As soon as it begins to get fixed, seize the

top of the cover with both hands, and pulling the cover toward you, push the bead into the clinch with your thumbs. There may be a tendency of the bead to get into the position shown in Fig. 143. Ease it gently by moving the lever from right to left, when, if it will not slip into place, the lever must be withdrawn, the part first placed in position taken back, and the operation repeated. If the cover is very recalcitrant, a notched lever may be employed to guide it into position, as shown in Fig. 144. Be careful that the lever does not slip in this operation, and also in fitting the last portion of the tire, where the work must be carried on by lengths of three or four inches at a time. During the fitting, whenever a bolt is reached, it must be pushed in so that the bead may pass under it and not get caught, as shown in Fig. 139. The

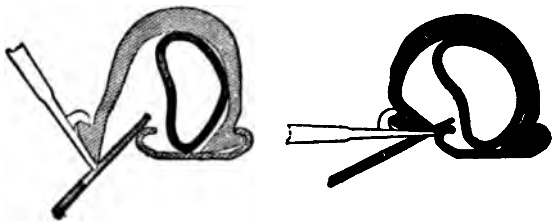


Fig. 144.—Manner of Using Notched and Flat Levers together to Replace Cover.

bead must be entirely hidden by the edge of the rim when the adjustment is complete. If the rim has been damaged, so that the bead can not be completely forced in, you will have to lace a band or gaiter over the place, inflate the tire as little

as possible, and drive slowly to the nearest wheelwright. When the cover is all on, see that the bolts do not nip the tube by pressing them in all around, when they should return slowly into position, under pressure of the air-tube. If the bolt is particularly hard to press in and comes back quickly, it is probably caught by the bead, as shown in Fig. 145.

A roadside repair to a cover can usually be executed without removing it entirely from the rim. With the tire open wide, a patch of leather should be cemented over one of cloth, with care not to use

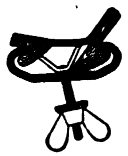


FIG. 145.—BEAD CAUGHT BY THE BOLT.

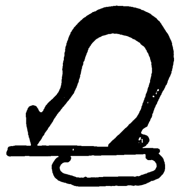


FIG. 146.—MANNER OF INSERTING LEVER TO REMOVE COVER ENTIRELY.

too much solution and to let it dry till tacky before applying the patches. If the cut is a very bad one, it is advisable to apply one of the special plasters sold for the purpose, to the inside, in addition to the external patches. In either case a laced gaiter or other bandage should be put on the weak place to protect it from sand and grit working in. If the cut is near the rim, a rubber wedge or protector should be interposed between the cover and the bandage to cause the latter to bind. Inflate slightly, say about fifteen pounds' pressure, before lacing on gaiter, and then inflate full. A very

bad tear or gash, after you have done your best with it and driven slowly to the nearest shoemaker's or harness shop, may be stitched up very creditably, so as to give you additional mileage with the aid of careful patches. Insist on the stitches being sunk well in the rubber, and place a patch over them on the inside to keep them off the tube. This and all patches on the cover should be liberally anointed with French chalk.

To remove the cover entirely, draw the free bead toward you and insert the lever till you get it in position shown in Fig. 146; then work round the wheel in this way till the cover is all free. Before removing the cover the security-bolts must be taken out, one by one, and laid carefully aside, with their nuts screwed a little way on them. The air-tube and valve must of course be removed, as already described, before attempting to take off the cover altogether. In refitting the cover, where the beads are of different diameters, remember that the larger one goes on first in the clinch nearest the car. Begin opposite the valve-hole and, with the bead farthest from you all over the rim, shove it into the clinch with one hand while you hold the cover with the other. When you get it well started, pry it home with the lever, inserting the edge of this underneath the bead from the inside, working always away from you. Do not let the outer bead slip into the rim at any point while fitting the inner. Next replace the security-bolts, lifting the outer rim with the notched lever for the purpose. Make

sure that the covers of the bolts, if any, are smooth before inserting the air-tube. If the tread becomes slightly detached from the cover on the road, it will have to be bandaged till you get home, and then carefully cemented with two coats of solution, after being cleaned with glass paper in the usual way. It must then be bandaged and the tire inflated, so that it may be left under pressure till thoroughly dry and firm at the edges.

Never run with deflated tires. Doing so for even the shortest distance will almost inevitably ruin both cover and air-tube. It is best always to carry at least one spare air-tube as insurance against the necessity of so running.

To test the tire-valve for leakage, turn it up with outer end pointing to the ground, and immerse it in a glass of soapy or plain water; watch for bubbles.

Keep *new* tires out of the light as much as possible.

Never wash tires with a large quantity of water. Wipe off mud and dirt with a cloth or sponge well wrung out. It is best to remove mud after each trip, especially near the rims. When washing the car, have tires well inflated and wing- and valve-nuts tightly screwed up.

Use large tires; it will cost less in the end.

Probe all cuts on the cover after a trip to ascertain how deep they are and whether they necessitate the tire being sent away for repair. Clean all dirt and sand out of cuts as soon as possible.

Use repaired tubes and covers on front wheels wherever possible, as they are there subjected to less strain, and can be watched more easily in driving.

The extent to which the care of the car may be carried by activities in the home work-shop will depend more or less upon taste and circumstances. Some of the adjustments which must necessarily be made here are indicated in the preceding paragraphs, and the automobilist who is his own driver will hardly be able to escape these. Among additional tasks may be noted the thorough cleaning of the motor-cylinders, at least once a season, and the operation should extend to the exhaust-pipe and muffler. These must all be taken apart and incrustations scraped out. It is a good plan to pour a little gasoline or kerosene into the cylinders occasionally, and to crank the motor until this has worked through and cleaned the cylinder walls and piston-rings. This should be done in conjunction with cleaning the crank-case, the drain-cocks of which should then be left open for an hour to insure the removal of the kerosene before again applying the usual lubricant. A tablespoonful of prepared graphite for gasoline motor-cylinders to every gallon of cylinder oil will help maintain a smooth contact and good compression.

A clutch, when new especially, will probably need considerable attention. The engagement at first will tend to be too fierce. Wear and lubrication of the leather will overcome this, and may,

perhaps, cause the opposite fault of slipping. Do not use rosin in such a case. A little flower of sulfur or fullers' earth is good, and a first-class belt dressing still better. Should the clutch seize or bind, so that it can not be thrown out by ordinary means, ignition should be switched off instantly and the car brought to a standstill, but not too suddenly. The clutch may then be shaken out by pushing the whole car backward and forward, with the high gear engaged. Be careful to let in a new clutch very gently. When washing the carriage, let the clutch in so as to protect its surface from water. Some cars make provisions for easy adjustment of new clutch-leather. Where this is not the case, the operation is so tedious that it is, perhaps, best left to the mechanic.

The accumulator or storage-battery of the ignition circuit demands frequent attention. The acid solution should always cover the tops of the plates by at least a quarter of an inch. Loss by spilling must be made up with fresh solution, mixed in a glazed stone vessel, in proportions of about one of acid to six of water. The acid must be slowly added to the water, stirring with a glass or rubber rod. Where the loss is simply from evaporation, fill up to the proper measure with distilled water. Test the specific gravity of the solution frequently with hydrometer, and if too low, add fresh solution, removing some of the old by means of a rubber bulb; if too high, simply add distilled water. The points with which you must be familiar regarding

your accumulators are: (1) Which is the positive terminal. This is usually marked (+), and may be recognized from the chocolate-color of the plate. Pole-finding paper is also useful, especially on tour, for detecting an alternating current, both poles of which will redden the paper equally, but more slowly, than the negative pole of a direct current. (2) Whether the cell is charged or discharged. New cells should be put on charge immediately after covering the plates with solution. Remove the vent-plugs from each cell, while charging, to allow the escape of gas, and do not bring a flame near these openings. When the charge is nearly complete, a minute boiling will take place in the liquid, giving it a milky appearance. Continue charging about twenty minutes. Longer than this would overcharge the cells, which tends to loosen the paste. The best way to test, however, is by taking the voltage by means of a pocket-voltmeter, connected to the poles of the accumulator-cells while charging. If a battery is to remain idle, it should be charged fully and recharged at least once a week, enough to make it gas freely, or else discharged and filled with plain water. When the voltage of a battery falls below 1.7, it should be used no longer, but immediately recharged. If allowed to stand, it will deteriorate. (3) Whether the battery is short-circuited. This may occur in the external wires of the ignition system, or in the contact-breaker. If the battery runs down rapidly without being used, an internal short circuit, due to paste dropping out

of the positive plates and getting between the plates, may be suspected. Never probe into the cell with any metal, as this itself may short-circuit the battery or deteriorate the solution. Use glass or rubber. Never test an accumulator by causing a spark to pass between the terminals, as this is a short circuit and will ruin the cell.

A battery may be charged from a continuous-current electric-light circuit. The ordinary tumbler-switch may be employed, by turning it on and being careful to keep it turned on during the charging, finding the negative pole by means of moistened pole-finding paper, which will turn red in contact with it. Connect this pole to the negative pole of the battery and the positive terminal to the positive pole. The charging-rate given by the makers should not be exceeded, and if no ammeter and rheostat are at hand, lamps may be used, remembering that a 16-candle-power, 110-volt continuous lamp consumes, approximately, half an ampere. Six lamps, 16 candle-power, coupled in parallel, or three 32-candle-power lamps, will give a current of three amperes, which is about right for a 20-ampere-hour battery. Charging with the tumbler-switch is slow, the best way being to find the terminals of the fuse at the fuse-board controlling a cluster of lamps, cutting out all but the requisite number of lamps to give the current of desired amperage.

Chains should be taken off periodically, the links and rivet-holes examined, and new parts fitted, if necessary, and the chain boiled a short time in

mutton-fat. The excess should be thoroughly wiped off. With enclosed chains, it will probably be sufficient to rub the chain well with a thin paste of graphite and alcohol; the object in both cases being to get the lubricant into the crevices in a congealed state, to the exclusion of grit.

It may be necessary, in supplying a new gear, to time the engine, that is, to adjust the operation of the half-time shaft carrying cams which actuate the ignition, exhaust, etc. This adjustment is one of considerable delicacy, and usually full instructions are furnished by the makers of the car. No attempt should be made to run until such adjustment has been thoroughly tested, and is found to be correct.

Damp and moisture must be rigorously excluded from the ignition system. Allow no loose fringe of insulation at the wire terminals, which may collect moisture. Cut this away and dip the terminals in paraffin, removing sufficient to secure contact at the binding-posts. The better method is to enclose all posts and terminals in rubber sheathing, overlapping the wire insulation.

The most fruitful source of breakdown is the ignition system; next come tires; third, pumps and water circulation; then chains; and then the carbureter.

Lamps should receive frequent attention, the air-holes being kept clear of charred wick and other stoppages. In acetylene-lamps, the washing out of all residue in the generator should not be neg-

lected. Brass lamps, if their care becomes too onerous, may be bronzed as follows:

Bronzing Brass by Immersion in the Following Solutions

	Water.	Nitrate of iron.	Perchlorid of iron.	Permuriate of iron.	Nitrate of copper.	Tersulphid of arsenic.	Muriate of arsenic.	Potash solution of sulfur.	Pearl-ash solution.	Cyanid of potassium.	Ferrocyanid of potassium.	Sulphocyanid of potassium.	Hyposulfid of soda.	Nitric acid.	Oxalic acid.	Color.
No.	pt.	dr.	dr.	pt.	oz.	gr.	oz.	dr.	dr.	oz.	pt.	dr.	dr.	dr.	oz.	
1	1	5	..	..	..	..	..	..	..	..	..	..	..	..	..	Brown and every shade to black.
2	1	..	5	..	..	..	..	..	..	..	..	..	..	..	..	Brown and every shade to black.
3	1	16	..	..	..	..	..	..	..	..	..	..	16	..	..	Brown and every shade to red.
4	1	..	..	..	..	..	..	..	..	..	..	..	16	1	..	Brown and every shade to red.
5	1	..	..	..	1	..	..	..	..	..	..	..	..	..	1	Brownish red.
6	..	..	..	..	..	..	..	..	..	..	1	..	..	3	..	Brownish red.
7	1	..	..	..	..	..	..	..	..	1	..	..	..	4	..	Dark brown.
8	1	..	..	..	..	30	..	..	6	..	..	..	..	..	..	Yellow to red.
9	1	..	..	..	..	..	..	1	..	..	..	..	..	..	..	Orange.
10	2	..	..	1	..	..	..	..	..	..	..	..	..	..	..	Olive-green.
11	1	..	5	..	..	..	..	..	..	..	..	2	..	..	..	Slate.
12	1	..	..	..	..	..	..	..	..	..	..	..	20	..	..	Blue.
13	1	..	..	..	..	..	1	..	..	..	..	..	..	..	..	Steel-gray.
14	1	..	..	2	..	..	10	..	..	..	..	..	..	..	..	Black.

N. B.—In preparation of No. 5, liquid must be brought to boil and cooled. In using No. 13, the heat of the liquid must not be under 180°. No. 6 is slow in action. The action of the others is for the most part immediate.

CHAPTER XII

THE AUTOMOBILE IN COMMERCE

Despite the visual evidence daily before us of the extent to which the automobile enters into the life of trade, it must be admitted that the self-propelled vehicle has been comparatively slow in taking the place of the draft-horse. Unquestionably there still exists much ignorant prejudice which militates against the wide-spread adoption of the machine in this important sphere. In justice it must be said, however, that during the first decade of its ascendency, the car itself has had to assume the burden of proof, which is heaviest of all, in an attempt to meet the rigid requirements of doing business. The workaday world will not brook delays and experiments; its products must be kept moving and its engagements fulfilled, barring nothing save "an act of God." Here the machine had to compete with an animal which, for centuries, has held the record for simplicity, reliability, and endurance. The conquest could hardly be expected to be an easy one in any case, and for the horseless vehicle to have made such inroads as it has during its experimental stage, is only another of the many won-

ders which the new invention has introduced into modern life.

Large credit must be given the foresight and courage of those real "captains of industry" who, realizing that the automobile in commerce furnished at first only the means for working out a problem, nevertheless confidently set themselves to find the solution by adopting it. Until the dawn of this present century, it must be said that such a course called not only for a pioneer, but almost for a plutocrat. Take the sphere of the hackney-carriage alone, where it is sought to transport individuals in cities, to and fro, by means of the electric vehicle in competition with the horse. It looks simple enough. The machine is not complex, no more than the ordinary quality of "horse-sense" is required in the driver, the roads are the best obtainable, and the riding public is naturally predisposed to novelty. The New York Transportation Company was one of the first in this apparently lucrative field, and they now have one of the most complete and efficient equipments in the world, operating successfully upward of 500 vehicles for passenger traffic alone. Yet the president of the concern freely admits that, had they not had sufficient capital to enable the business to be run for many years at a heavy loss and actually as an experiment, it would long ago have been driven to the wall by precisely the same conditions that have caused the failure of a number of other similar concerns.

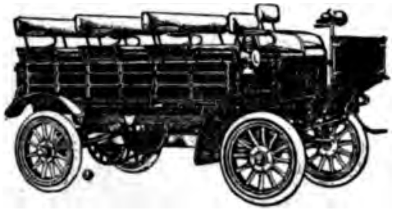
Now, however, the pioneer work of the commer-

Light Delivery Wagon. $1,000. 10 H. P.

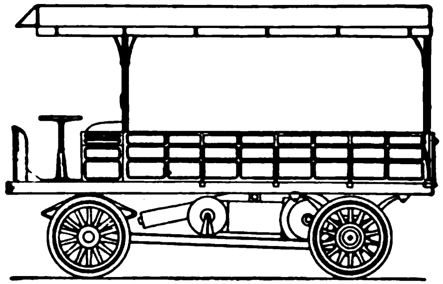
Convertible Light Delivery Wagon. $850. 8 H. P.

Heavy Delivery Wagon. $2,000. 16 H. P.

Light Passenger Bus. $2,200. 16 H. P.



Heavy Passenger Car. $2,500. 16–18 H. P.



Heavy Truck. $3,000. 20 H. P.

Fig. 147.—Some Types of Commercial Gasoline-Cars.

cial car seems to be pretty well accomplished, and the time should be ripe for a rapid and rational development of horseless transportation in all lines of trade. Indeed, this seems to be apprehended by the makers, at least. The movement of established automobile manufacturers toward the production of the commercial vehicle may be ascribed to two causes: First, a natural desire to increase the scope of their business, and second, to an unspoken but none the less deep-rooted conviction that in a few years the supply of vehicles designed for private use will have so greatly exceeded the demand as to produce a consequent period of depression like that in the case of the bicycle a few years ago. Should the present rush of automobile production continue, this would seem inevitable, and it is a wise precaution on the part of manufacturers to lay the foundations of an industry which will not only tide over any temporary depression in the demand for purely pleasure-cars, but which, in the nature of things, is bound to become of such importance as in time to completely overshadow the present development of the industry.

It is, however, impossible that a market for commercial vehicles should be created by the methods which have increased the business of automobile manufacture to such proportions in the course of the past few years.

The practical problems to be met and solved in the construction of delivery wagons and commercial vehicles generally, namely, of transmission and

power adjustment, are almost exactly the same as in a pleasure-car, the most important divergence being in the design of the running-gear. Reasons for failure in the past, in contests and in active service, have lain in the fact that designers were not sufficiently familiar with the best practise in motor construction as well as in transmission; consequently the power plant did not prove reliable. While the relative number of prominent manufacturers of automobiles at present delivering any number of commercial cars is small, it is nevertheless encouraging to know that several others, not less well known, are quietly experimenting with the development of one or more types of this sort of vehicle, and that there is a decided increase in the number of firms whose efforts will be directed solely to the production of delivery wagons or trucks, or both. It must be distinctly understood that the commercial and pleasure fields are quite distinct. In the former, the machines are largely operated on well-paved streets or smooth roads and under most favorable conditions. When allowance is made for disuse during the heavy winter season, rainy days, etc., the pleasure-vehicle probably will not average more than twenty-five miles a day in the course of a year. The commercial vehicle, on the contrary, must be operated in all sorts of weather, and frequently be driven by employees who are either ignorant or careless, and neglect the care that the private owner would give to the running and handling of his car. Therefore the deliv-

ery automobile must contend with ignorance and incompetence; in other words, must be "fool-proof."

It seems strange, with the rapid development in use of automobiles of all sorts for various purposes of traffic, that their feasibility as a means of delivering goods, both in the city and adjacent districts, has not appealed more strongly to small shopkeepers. While it is true that many large department stores have made use of the commercial vehicle, even they have not done so to the extent that would seem natural when we consider the increase of trade which might be supposed to follow on the heels of a rapid, efficient, and, best of all, comparatively inexpensive system of parcel delivery. Moreover, the smaller establishments, which are only able to afford one horse and wagon, find more than one daily delivery difficult, if not absolutely impossible. Here the advantage of an automobile becomes more than ever apparent, since it does not need time for meals, it never gets tired, and thus can deliver profitably at a distance as well as near at hand. The development of the electric street-railway service has resulted in such a wide distribution of urban and suburban population, that the retail merchant finds the delivery of goods a problem growing each succeeding year more difficult of solution. An equipment of from twenty to one hundred wagons, frequently necessary for large stores to accomplish regular deliveries, is no inconsiderable item of running expenses. When we consider that many of the medium-sized cities of the

United States cover an area of thirty square miles, with hundreds of miles of streets, and that the average horse, year in and year out, can not hope to accomplish more than twenty miles a day, it will be readily seen that the question of regular and economical delivery is a very perplexing one. This is also true in the wholesale field, since small dealers are likewise becoming more widely scattered, entailing rapid increase in the expense of delivering goods to them.

As to the motive power best suited to commercial cars, there is no very definite line of demarcation. Electricity seems to hold the field at present in this country both for passenger and freight traffic in cities. Abroad, particularly in England, the heavy steam-truck is quite extensively used. The adaptability of the steam-motor to varying loads, and the ease with which its operation and maintenance is understood by the average driver, make it highly suitable for the purpose. In the latter respects, however, it is excelled by the electric motor, which may be driven almost without previous experience. The present scarcity of reliable automobile chauffeurs gives an inflated value to the services of any one understanding the specialized machinery employed. On this account many concerns have been deterred from using steam- and gasoline-trucks because, as soon as their drivers became sufficiently expert, they secured positions as private chauffeurs, necessitating the constant breaking in of green drivers.

The steam-truck is particularly unsuited to any form of traffic where many stops and long waits are involved, since its fire- and boiler-pressure require constant watching. The gasoline-machine is superior in this respect, and the electric obviously preeminent. The steam-motor might be expected to prove its special value in relatively long hauls, but so far, in this country, it has not had much opportunity to show what it can do in this respect. In commerce, as in pleasure-touring, the automobile is still seriously hampered by the need of good roads and by the grudging way in which a moiety of the road has been accorded it. When we consider the possibilities of the open road as an avenue of traffic for merchandise which it does not now pay the railroads to handle promptly or to handle at all, we may safely predict that the future influence of the automobile on commerce will be little short of revolutionary. There is no good reason at the present time why small freight can not be collected from the door-step, hauled a hundred miles, and delivered to the consignee direct from the same wagon. Already there are signs that a sudden awakening to this fact is imminent, and when it comes a greater impetus will be given to the automobile industry than can now be realized.

Already so many and varied are the applications of the automobile to commercial use, that a complete survey of the field is impossible in brief compass. In passenger transportation the automobile was preempted, at the start, by the already wide

Courtesy of *The Automobile Magazine.*

A FARMER USING THE AUTOMOBILE FOR SHELLING CORN.

ramifications of the urban and suburban trolley. Yet even here is has met with success. In cities of any size the self-propelled omnibus using steam, electricity, or gasoline is now a common sight, while several trackless trolleys are in serious operation at Monte Carlo and several German cities abroad, and at Scranton, Pa., in this country. In isolated districts the old stage lines have in some instances yielded to the new invention, and are bound to disappear as completely as has the horse-drawn street-car of our forefathers. One of these routes in the Far West covers sixty miles through the roughest kind of mountain territory. The establishment of local automobile liveries where machines may be hired without incurring the burden of their care, or even their running, is an increasingly profitable business. The rural commercial traveler finds the car of inestimable service in increasing his mileage per day and his independence of the railroads. The day may not be far distant when the traveling public will prefer the automobile for short distances; for when unnecessary speed restrictions are removed from our roads the car will furnish all the delights without any of the disadvantages of the old coaching days for which we all occasionally sigh.

The City Council of Vienna, Austria, early in 1905 voted to equip the fire department with electrically propelled hose- and ladder-wagons instead of the fifty-three horse-drawn vehicles now in use. The saving in cost and maintenance thus effected is

calculated to pay for the new equipment within eight years. A considerable number of foreign cities have already adopted horseless fire equipments, and some of our own cities are experimenting with them.

The German Government is reported to be planning the extensive employment of automobiles in connection with the Imperial mail service and the Government railroads, including the delivery of freight and express goods in country districts. At Speyer, Germany, a combined mail and omnibus service has been in successful operation for the past six years over a very long route. Communication between small towns in this manner has been established in Porto Rico over a distance of fifty-two miles, in Algiers, and even in Madagascar. It seems that the automobile should be particularly useful in the distribution of mail in large cities. Berlin has a number of gasoline-motor tricycles in use for this purpose, and Paris employs upward of fifty electric wagons of a type which has been adopted as the standard equipment of the department. The Russian Government has been experimenting with gasoline mail wagons at Odessa, and the Austrian army in Bosnia employs a similar vehicle as a sort of postal diligence. Post-offices in some of the larger American cities have employed the automobile experimentally, with encouraging results.

Gasoline automobiles are employed to a considerable extent as auxiliaries in railroad work, for

inspection-cars, and in general where it is desired to get quickly over the line at less expense than would be involved in the use of a pilot-engine or special car. Such automobiles are being used to pick up men from shunted cars in yard work, doing this more quickly and at great saving of time to the yard engine.

One of the most remarkable displacements of four-footed beasts by the automobile has taken place on the desert plains of Nevada, where an automobile train of special construction has been substituted for the transportation of borax, formerly hauled by teams of twenty mules each.

CHAPTER XIII

THE AUTOMOBILE IN SPORT

As a companion picture to the automobile delivering packages from door to door, we may catch a glimpse of it as it flashes by on some carefully selected course, making world's records for speed, with its time electrically determined in the presence of a myriad enthusiasts. Considerations of the economic value of sport in national life are useful on a rainy day for the purpose of killing time, but are not much entered into by the watcher of a modern automobile race, and not at all by the racers themselves, whose nerves and mentality are taxed to their utmost. Nor will the average man be much inclined to abstract reflections when he observes how the automobile itself has been annihilating time during the past ten years. The first officially recorded time in a modern automobile meet is that of M. Levassor, who, in a car driven by a 3½ H. P. Daimler motor, finished the Paris-Bordeaux race of 1895, a distance of 1,200 km., in 48 h. 47 m.; average speed, 24.5 km. per hour, or about 15 miles per hour for about 745 miles. The world's record for 1895 for 100 miles, made by H. W. Fletcher, of New York, at the Ormond-Daytona

meet in Florida, with an 80 H. P. de Dietrich car, is 1 h. 18 m. 24 s.; an average of 75 miles per hour. At this same Florida meet the world's record, 21⅗ s. for one kilometer, made by Baras at Ostend, was undoubtedly lowered by Henry L. Bowden and his 120 H. P. Mercedes, which was timed unofficially for one mile at 32⅘ s. So great is the fascination of speed, that any organized sport for its supreme manifestation is bound to work out its own salvation, no matter what the cautious may say. The fact that it must have cost Mr. Bowden over $50,000 to make this unofficial record, seems of little moment to the public or to the sportsman in the face of the record itself. Nor is it of any moment, provided the record was worth making. There are those who advance the opinion that the limits of sport have been reached in the racing of automobiles. But there is no real limit to sport, a fact evidenced by the steady increase of interest as the conditions of racing have become more and more highly organized. If there is a limit, it must be one of utility. It is true that a comparison between the earlier and the present conditions is very much like that between the manner of conducting college athletics now and in the days of our fathers. The old teams were good for the individual, the modern team is good for the college. The early automobile trials were over roads and under circumstances more likely to confront the average driver; consequently they demonstrated many valuable things and gave to a new industry an impetus of

exactly the kind it required, by inspiring confidence in an unfamiliar means of locomotion and proving its rudimentary capabilities. The modern race also demonstrates what the automobile is capable of, considered purely as a mighty mechanism calling for the highest qualities of human nerve, skill, and judgment to control it. Such demonstrations must necessarily react just as keenly, though apparently more indirectly, upon the individual and the industry. Those who hold that "'t were to consider too curiously to consider so," will point out the justly deserved popularity of the Mercedes car among average automobilists, and will urge that the success of the car in this particular was not due to racing successes, since the Mercedes construction has not been based upon achievements of this kind. The Ormond-Daytona mile in $32\frac{4}{5}$ s., however, was achieved by two 60 H. P. four-cylinder Mercedes motors, one taken from an ordinary car and the other from a launch, both working in line, and practically independently, on the same crank-shaft, which was made of two pieces of nickel steel. Yet, after all, the lesson is simply that the Mercedes design is a good one for developing power where it is needed, and rendering it available for any purpose, of course making due allowance for Mr. Bowden's clever adaptation. That the French automobile industry was literally born and swaddled in racing is not the sole reason for the preeminence hitherto of the French motor in the sport; nor does it account fully for the many

excellent adaptations of their motors by French manufacturers to the every-day needs of the road. It is true that the French have paid special attention to racing construction, and equally true that constructors of other nations have been quick to avail themselves of any points made manifest by rigorous trials of speed and strength. It is in the light of the intelligence and sound experience of the trained mechanician that the industry advances. Freak cars may be built and may attain a temporary prominence in racing events, but the general trend of development in both industry and sport will be, as it has been, toward the survival of the fittest types and toward their improvement in accordance with tried principles broad enough to cover all the purposes for which an automobile-motor may be required.

Manufacturers have learned much from sport, and they will learn much more, provided the regulation of the conditions of trials remains in the hands of true sportsmen wise enough and fearless enough to insist on contests which really show something. This seems likely to be the case, since the fostering interest of the various associations of gentlemen constituting our clubs is still in the ascendent. That the conditions of the modern race, like those of the human race, might be improved, no one doubts. But the building of racing-cars as practised to-day, if it had no other use, is invaluable to the average automobilist, since it detects and eliminates the structural weaknesses of his machine

before it reaches him from the hands of reputable manufacturers. A race is the most inclusive and severe test to which a car can be put. Stresses of vibration, statics, dynamics, torsion, are all brought into play at once. Laboratory tests of materials are valuable, but they can not compete in value with the final trial of the driver, who proves whether the metals employed are satisfactory for the work to be done.

That manufacturers find these contests of value in interesting the general purchaser, can not be doubted, from the sums spent by them in the effort to put a winning car in the field. One French concern, whose car won an important race in 1904, found themselves at the beginning of 1905 overwhelmed with orders far in excess of their capacity, and with their existing cars selling at a premium. The advantage to the concern, as stated by the general manager, is "because it has made it possible to increase the price of our cars without, however, making these prices higher than those of well-known competitors." This shows pretty clearly the temper of the automobile-buying public in regard to the economic value of sport. That the interest is of a substantial kind, must be apparent, since otherwise it could hardly be profitable for makers to undergo the heavy expenses involved. In addition to the heavy cost of the specially constructed racing-car, ranging from $20,000 to $50,000, there is the entrance fee; for example, $1,000 in the Gordon Bennett race, or $2,000 in the French

Courtesy of *Motor*.

THE FREAK RACING-CAR KNOWN AS THE "TEA KETTLE."

A 20 H. P. steamer in which Louis S. Ross covered a mile in 38 seconds, winning the record for steam-cars at the Ormond-Daytona tournament, January 26, 1905.

Courtesy of *Motor*.

WALTER CHRISTIE'S 60 H. P RACER WHICH COMPETED IN SEVERAL EVENTS AT THE ORMOND-DAYTONA MEET.

Eliminatoires. Chauffeurs are paid all the way from $1,000 to $2,000 for driving a car in these races, with a bonus of from $4,000 to $8,000 in case of victory.

The construction of the racing-car differs little in principle from that of the ordinary high-powered roadster. Considerations of transmission, control, silent and easy running, are, however, of minor importance, the supreme effort being to render directly available as vast a power as possible, upon a framework in which lightness and strength are combined in such a way that the whole mechanism may be hurled through the air in one overmastering rush. Some idea of the nature of these "monsters" may be gained from the table on page 286:

In general the racing-car should not weigh over 1,000 kg. (2,204 pounds), or 650 kg. (1,432 pounds) for the middle-weight class, when weighed with tanks empty and batteries removed. So careful are the tests to which these machines are subjected, that it is customary to take a barometer-reading as part of the speed test, to determine the capabilities of the car, since the power of the motor may fall off a fifth of a second or more when the barometer is high, due to the slightly decreased weight of the explosive charge. The water- and fuel-tanks of the track-racer are usually much smaller than of the road-racer. Fewer speed-gears are provided for the former, in which also more attention is paid to wind-resistance by making the car narrower and seating the driver lower;

DETAILS OF THE RACING CARS THAT COMPETED AT ORMOND, FLA.

	Weight lbs.	No. Cylinders.	Bore and stroke.	H. P.	Number speeds.	Kilometer Record.	Mile Record.	Tires.
						Sec.	Sec.	
H. L. Bowden's Mercedes.......	2,600	8	5 3-4 x 5 7-8	120	1	23 3-5	34 1-5	3 Michelin, 1 Continental.
Arthur McDonald's Napier	2,203	6	....	90	2	23	34 2-5	Dunlop.
Louis S. Ross' Stanley Steamer..	1,650	4	....	90	..	24 1-5	38	Diamond.
Henry Ford's Ford............	1,660	6	6 x 6	60	1	.....	.....	....
Chas. Deplus' Pipe............	2,193	4	175 x 145 m.	80	4	32 3-5	43 2-5	Continental.
Walter Christie's Special........	1,975	4	6 3-16 x 6 3-4	60	2	.....	42 1-5	G & J
Guy Vaughn's Decauville.......	1,422	4	5 1-8 x 5 1-8	40	3	.....	48 1-5	Continental.
William Wallace's Fiat.........	2,200	4	165 x 165 m.	90	4	32 2-5	39 1-5	Michelin.
B. M. Shanley Jr.'s Mercedes....	2,203	4	6 5-8 x 5 1-2	90	4	34 3-5	44 1-5	Continental.
W. K. Vanderbilt Jr.'s Mercedes.	2,202	4	....	90	4	28 3-5	42 3-5	....
S. B. Stevens' Mercedes.........	2,204	4	6 5-8 x 5 1-2	90	4	26 2-5	39 2-5	Continental.
E. R. Thomas' Mercedes........	2,202	4	5 1-0 x 6 5-8	90	4	26 3-5	40 2-5	Continental.
A. C. Webb's Pope-Toledo......	2,204	6	5 1-2 x 5 1-2	75	1	.....	.....	Diamond.
H. W. Fletcher's De Dietrich ...	2,189	4	....	80	3	.....	.....	Continental.
W. Gould Brokaw's Renault	2,034	4	6 x 5	60	3	.....	45 2-5	Continental.
A. G. Vanderbilt's Fiat.........	2,200	4	165 x 165 m.	90	4	28 4-5	45 1-5	Continental.
Webb Jay's White	1,400	2	....	15	..	44 2-5	51 4-5	Diamond.
James L. Breese's Mercedes.....	2,204	4	....	35	4	.....	53 2-5	Continental.
Webb Jay's White	2,180	2	....	40	..	.....	.....	Diamond.
Barney Oldfield's Peerless	1,800	4	5 3-4 x 5 3-4	50	1	.....	49 3-5	....

and in general the track-car is hung lower, to prevent overturning on curves. Special points of construction have been developed in so-called "beach-racers," which are a still further refinement on the ordinary track-car. Disks instead of spokes are employed on the wheels to prevent loss of power by air-churning, which is often as much as 5 per cent.

It is not, however, from the performances of the specialized racer alone that these contests have their value. The more directly valuable results of the earlier and simpler contests are still attained in the open or free-for-all events, the events restricted to amateur drivers, and those in which "stock-cars" from the ordinary market are alone allowed to compete. A glance over the thirty-six events planned for the Ormond-Daytona meet of 1905, given in Appendix III, will show the scope of one of these modern contests.

The history of automobile-racing is brief enough. The two earliest races, that from Paris to Rouen in July, 1894, and its offspring from Paris to Bordeaux and back, June 11, 1895, have already been several times mentioned in these pages. The following year, July 24, 1897, the Paris-Dieppe race of 106 miles was won by a Panhard car of 6 H. P.; time, 4 h. 36 m.; average speed, 23.1 m. per hour. Two persons were carried on the car.

Important events which followed were the race from Paris to Marseilles and back, 1,061 miles, in September, 1896. Two 4 H. P. Panhard cars finished nearly together, the time being 67 h. 43 m.,

and 68 h. 11 m. respectively; average speed, 15.65 and 15.55 m. per hour. Each car carried four persons.

Three important races were run in 1899: (1) Nice-Castellane and back, 74.6 miles, 56.6 miles being over a hilly course. The weight of the cars competing could not be less than 440 pounds. A Peugeot 17 H. P. machine completed the course in 2 h. 53 m.; average time for whole course, 25.8 m. per hour; for hilly portion, 23.8 m. per hour. (2) Paris-Bordeaux, May 24th, 351 m. covered by a Panhard 12 H. P. car, carrying two persons, in 11 h. 43 m.; average speed, 30 m. per hour. (3) Tour de France, 1,440 m., July 16th, won by de Knyff in a 16 H. P. Panhard car, in 44 h. 43 m.; average speed, 31.7 m. per hour. Other races during this year were the Paris-St. Malo, 226 m., won by Antony in a Mors 16 H. P. car, in 7 h. 13 m.; Paris-Ostend, 201 m., tied by Levegh in a 16 H. P. Mors, and Girardot in a 12 H. P. Panhard; time, 6 h. 11 m.; average speed, 32.5 m. per hour.

In 1900 the Circuit du Sud-Ouest, 208 m., was won by de Knyff in a 16 H. P. Panhard, in the remarkable time of 4 h. 46 m. 57 s.; average, 43.5 m. per hour; credited on one stage with 34 m. in 33 m. 30 s. The Nice-Marseilles race of this year (1900) was also won by de Knyff, at an average speed of 36.6 m. per hour for the 125 m. Levegh, in a Mors, won the La Turbie hill-climb, 10.5 m., at 33.1 m. per hour; the mile race, at 36.5 m. per hour, and the flying kilometer at 46.5 m. per hour. In the Bor-

deaux-Perigueux-Bordeaux race he covered the 195.5 m. in 4 h. 1 m. 45 s.; accomplishing the first stage (72 m.) at the rate of 51 m. per hour.

The first race for the Gordon Bennett International Cup was run this year (1900), from Paris to Lyons ($353\frac{3}{4}$ m.), and was won by Charron in 9 h. 9 m. in a Panhard; average, 38.4 m. per hour. In 1901 the Gordon Bennett and the Paris-Bordeaux races were run simultaneously over the same course. In the former only one car finished, a 40 H. P. Panhard, driven by Girardot, 328.1 m., exclusive of controls, in 8 h. 50 m. 59s.; average, 37 m. per hour. The latter race was won by Fournier in a 60 H. P. Mors; time, 6 h. 10 m.; average, 53 m. per hour. In the Coup de Rothschild flying kilometer at Nice the same year, a Serpollet steamer made the remarkable time of $35\frac{4}{5}$ s., or $62\frac{2}{3}$ m. per hour. The La Turbie hill-climb was won by Baron de Rothschild's 35 H. P. Mercedes, 10.5 m. in 18 m. $6\frac{4}{5}$ s., or $31\frac{1}{8}$ m. per hour. The great event of 1901 was the Paris-Berlin race, 749 m., covered by Fournier in a 28 H. P. Mors, in 16 h. 5 m., net time after deducting 8 h. for controls; average speed, 46.5 m. per hour over the three days' course.

Another of these long-distance races was run in 1902 from Paris to Vienna, June 27th to 29th. The 616.4 miles were covered by H. Farman in a 70 H. P. Panhard; total time, 16 h. 0 m. $30\frac{1}{5}$s. The Gordon Bennett race was run simultaneously over this course, and the trophy won by S. F. Edge in

a 60 H. P. Napier car. On July 31st was run the Circuit des Ardennes, won by Jarrott in a Panhard; time for the 318.7 miles, 5 h. 53 m. 39⅗ s.

A race from Paris to Madrid was begun on May 24, 1903, but was abandoned at Bordeaux, where the first car to arrive was a Mors, driven by Gabriel; time, 5 h. 13 m. 31 s. for the 351.4 miles. The Gordon Bennett race of this year was run in Ireland, and was more truly an international event than ever before—England, France, Germany, and America being each represented by three cars. C. Jenatzy finished first in a Mercedes; time, 6 h. 39 m. for the 368.43 miles.

America's first international road race was held October 8, 1904, over the Jericho Road at Garden City, L. I., N. Y., in competition for a cup offered by W. K. Vanderbilt, Jr. The total distance, from start to finish, was 302.4 m., including controls. The distance, exclusive of controls, 284.4 m., was divided into ten laps. Heath, in a 90 H. P. Panhard, finished first; total time, exclusive of controls, 5 h. 26 m. 45 s.; including controls, 6 h. 56 m. 45 s.; average speed in net running time, 52.2 m. per hour, or .87 m. per minute. Clement, in a Clement-Bayard car, finished second, 4 m. 28 s. behind Heath. A 24 H. P. Pope-Toledo touring-car, driven by H. H. Lytle, finished third; average speed in net running time, 42.6 m. per hour. This car made the most uniform performance in the race, the greatest variation in its time for any two rounds being 2 m. 3 s., except in

START OF THE 90 H. P. PANHARD.

Driven by Tart in the Vanderbilt cup race on the Jericho Road, Garden City, Long Island, N. Y., October 8, 1904.

AT FULL SPEED.

Clement in the 80 H. P. Clement car that finished in second place, one minute and twenty-eight seconds behind Heath, the winner of the Vanderbilt cup race.

the seventh round, where half an hour was lost because of tire trouble. The fastest round (28.44 m.) was made by Teste in a 90 H. P. Panhard; time, 24 m. 4 s. Cars of American, French, German, and Italian manufacture, to the total number of eighteen, competed. The first three only had finished the tenth round when the race was called off.

The year 1904 marked the first international tournament on the Ormond-Daytona beach in Florida, as well as a number of minor but highly interesting racing events throughout America, in several of which world's track records were made.

In addition to these speed contests, of equal interest from the standpoints of both sport and industry, are the various road races and trials which have followed in the wake of the automobile, both here and abroad. The earliest of these in America were the Chicago *Times-Herald* trials of Thanksgiving Day, 1895, in which six gasoline and two electric cars competed. The course of seventy miles was through snow a foot deep. A Duryea, a Benz, and a Roger car finished first, second, and third, respectively. The Cosmopolitan race, from City Hall, New York, to Irvington-on-Hudson, a distance of 52 m., held on Decoration Day, 1896, was also won by Duryea vehicles. The hill-climbing contests held at Charles River Park, Boston, in 1897, in which a Stanley steam-car carried off the honors, also belong to this early period.

Two 100-mile non-stop trials were held in 1902;

one by the Automobile Club of America, from New York to Bridgeport, Conn., in which 55 cars started and 28 finished. The other was held by the Long Island Automobile Club at Roslyn, Long Island, April 26th. Of the 66 cars that started, 37 finished; fastest time, by the Automotor Company's Keleconn car, 6 h. 20 m. 15 s. A 2,800-foot hill-climb, maximum grade 8 per cent, was held at the same meet; fastest time on hill, 1 m. 19 s., by a Rochet-Schneider 12 to 16 H. P. car; a 3½ H. P. Locomobile and a 15 H. P. Winton both making the distance in 1 m. 42 s. Brake tests were held May 1, 1902, at New York, and June 24, 1902, at Philadelphia, results of which are tabulated in Appendix II.

An event which opened the eyes of the American public to the long-distance possibilities of the automobile was the endurance-run from New York to Pittsburg *via* Cleveland, held under the auspices of the National Association of Automobile Manufacturers, starting from Weehawken, N. J., October 7, 1903, under weather conditions which grew steadily worse during the run, and tied up even railroad traffic all along the course. Yet the first cars arrived in Pittsburg by noon of October 15th, conquering road conditions and obstacles which would have been impossible to horse-drawn vehicles. Of the 46 cars which started, 10 completed the run on schedule time. The first endurance-run to be held in America was planned by the Automobile Club of America in 1901 from New York to Buffalo. Of the 80 cars that started on September

9th, 42 reached Rochester, where the run was abandoned on account of the death of President McKinley. In 1902 the A. C. A. held a 500-mile reliability-run, from New York to Boston and return, in which 75 cars started and 17 completed the course in accordance with the regulations. Endurance-runs for stock-machines have been made from time to time in all parts of the country. One of the most interesting was that from San Francisco to New York in August, 1904, in which a 10 H. P. Franklin covered the 4,500 miles in less than 33 days, against the best previous record of 61 days. The car covered the distance from San Francisco to Ogden (Utah) in 10 days, and from St. Louis to New York in 5 days, 21 hours. The course included a climb of 7,256 feet over the Sierras, as well as a long run over the alkali desert, where the temperature was over 100° F. most of the time. Important hill-climbing contests have been held annually at Eagle Rock, near Orange, N. J., since November 27, 1902. On July 12, 1904, a contest was held up the side of Mount Washington.

From the preceding brief and necessarily incomplete survey, some idea may be gained of the proportions already assumed by automobilism in the sporting world. How rapid the development has been, may be indicated by the one fact alone, that previous to 1905 there was no attempt made to file official records with any recognized body in America. This being now done with the Automobile Association, it will be possible in the future to

trace the performances of the machine in various lines and to compare results with greater facility.

The Gordon Bennett Cup has become the Blue Ribbon of the sport. The contest for it is to be held in 1905 over the somewhat difficult Auvergne course as a distinct event, the Automobile Club of France having abandoned an attempt to combine it with their new Grand Prix race.

Just what the development of high motor speeds will lead to, it is, of course, impossible to predict. The fastest mile record claimed for any railroad does not exceed Mr. Bowden's mile in 32⅘ s., yet the latter was made over an accurately measured course, timed electrically by six chronometers, all agreeing within one-tenth of a second, while railroad records are usually made between mile-stones, under methods admitting of a large personal equation. A short burst of speed is mechanically the weakest point of the automobile and the strongest of the locomotive. Over a carefully laid track, with curves and grades calculated to a nicety, no railroad schedule exceeds a mile a minute for protracted distances. Against this we may set the 100-mile run of Mr. H. W. Fletcher, with an 80 H. P. machine, made at Ormond, in 78 m. 24 s., including seven turns and seven stops and starts.

An imaginative enthusiast has pointed out that, with a speedway such as the Florida beach extended round the world, the circuit could be made in about ten days, were Mr. Bowden's machine capable of exerting its supreme power continu-

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Courtesy of *The Automobile Magazine.*

AN EXCITING MOMENT ON THE EMPIRE CITY TRACK.

VIEW OF THE NEW MORRIS PARK RACE-TRACK FOR AUTOMOBILES.

ously. The world of 1805 had not dreamed of the railroad. The railroad of 1850 had not dreamed of a mile a minute. The automobile of 1895 was regarded as a dream itself. The world no longer gasps at performances of high speed; it thirsts for them, because it has come to realize that speed is not necessarily incompatible with safety. Nevertheless the limitation of speed upon our common roads still remains in a primitive state, although any one of average intelligence will admit that the real test of danger is the distance in which the vehicle can be brought to a stop. In this respect the automobile has proved itself superior to both the horse and the locomotive. Whither the thirst for speed, the dreams of annihilating space, will lead us, no one knows. Certain it is, however, that traffic conditions are changing, and will change still more in the next quarter century. Whether road-building, public temper, and mechanical skill will ever enable us to journey to Chicago and back in twenty-four hours by automobile, time alone will reveal. Enthusiasts are found who think that such a feat is within man's power even now, if he would but utilize the means at his disposal. But in every sphere of human development it is as bad to go too fast as too slow, and the future of the automobile will have to be worked out like that of any other new force in which the pendulum of human effort swings between the marvelous and the commonplace.

CHAPTER XIV

TOURING

It is in being able to wink " at 'Omer down the road " and at all other " ancient landmarks which the fathers have set," that the automobilist realizes the beatitude of the exalted horn. He can realize it to the full only on the open highway. Here the machine is at its best, and sometimes, let us admit, at its worst. In either case his mechanical skill receives its greatest stimulus and justification. In our own wide land the very existence of the road is the esthetic *raison d'être* of the automobile. The quiet country road furnishes the ready avenue of escape from the ever-increasing complexities of modern life, and unfolds a panorama which soothes the spirit and corrects any distorted notions man may have conceived about his place in the universe. Yet with the car he is lord of the road, mastering its limitations at will or yielding to its ancient spell and forgetting his new power to " fare on, the foot-path way," the better to drink the medicine of mother earth. It is no wonder that with the vernal quickening of nature, according to Dan Chaucer, " thanne longen folk to goon on pilgrimages " ; the roving instinct is as old as the race, and it is a very prosaic

XIV

A FAMILY PARTY ON TOUR FROM SAVANNAH, GA., TO BUFFALO, N. Y.

automobilist, indeed, whose pulses do not quicken at the thought of being able to travel when and where he will, dependent solely on his own resources, yet with means to render available as much or as little as fancy dictates of the modern inconveniences of civilization. On tour, the car, from the purely human standpoint, renders the fullest fruition of its being. Rightly viewed, the many inventions sought out by men in a highly organized state of society are but for the purpose of placing more readily within his grasp so much of the basic desiderata of life as may be useful or pleasant for him. The touring-car places at man's feet so much of the simple life of a former age as may be pleasant for him, and useful in keeping him a sweet and wholesome human creature.

If we want evidence of the truth of the foregoing, it is to be found in the universal popularity of the high-powered touring-car and in the present wide-spread endeavor of makers, by means of special designs and fittings, to produce a light car capable of sufficient radius to meet the demands of the average purchaser. The automobilist who does not want a car in which he can tour, no matter what else he uses it for, is the exception.

But the automobilist, once he is minded to take to the road, may be safely left to erect his own enthusiasms, enjoy his own sensations, and make his own "poetry of motion," for at first he will be confronted by rather more practical considerations. Foremost among these is the road itself—that un-

explored labyrinth, around every corner of which there should be something to set some of his five wits a-tingle. Yet the most adventurous and expectant knight errant of the car will scarcely be willing to leave all the surprises of the road to chance, lest he be overtaken in an ignition fault or a tire trouble, or drive gaily into a veritable slough of despond, there to break down entirely with wailing and gnashing of gear-teeth.

Unfortunately, despite the preparatory crusade of the bicycle, there is still more than one road "paved with good intentions." To be sure, there are as fine stretches of road in America as anywhere else in the world; the only trouble is that they do not stretch far enough for the automobile. Some of them start out bravely enough, and then, just as the driver is beginning to think he will never travel by rail again, they suddenly "go to the bad" in a way that impoverishes language, and in a State where there is an old blue law of arrest for profanity. It must be said, however, that the older States are not the worst offenders in this respect. If all roads, both shore and inland, were as uniformly good and well kept as those in New Jersey, the tourist need not complain; nor if every State Highway Commission were as active as that of Massachusetts, which in one instance is spending $50,000 to make good a difficult four-mile stretch of road in the Berkshires; or as that of New York, which has turned the perfunctory "publication and distribution of a compilation of the high-

way laws" into a 500-page book, containing some of the most scientific information and practical suggestions on road-building ever published, together with addresses on different phases of the road question by prominent authorities.[1] The State of New York will submit to its voters, in 1905, an amendment to the State Constitution to permit of a $50,000,000 bond issue, the proceeds of which are to be devoted to the building of good roads throughout the State. Pennsylvania has already appropriated the sum of $6,500,000 for the same purpose, and other States are following in the greatest movements for good roads ever inaugurated in this country. There is a bill before Congress to secure appropriations to be made available in connection with the various State appropriations for the construction of a number of great national highways. A fitting and desirable point at which to begin such improvements would be the Old Cumberland Road, first conceived by Washington, during his Indian campaigning of 1752–'53, as the great connecting-link between the East and West. Albert Gallatin also was active in the project, and in 1806 Thomas Jefferson appointed a commissioner to report upon it, with the result that the first contract for the ten miles west of Cumberland, Md., was let in 1811. The road was opened to Wheeling, W. Va., in 1818, at an average cost of $13,000 per mile. The last appropriation was made in 1838, carrying the road

[1] Highway Manual of the State of New York. Lyons, N. Y., Charles H. Betts, Chief of Revision Department, State Assembly.

as far as Vandalia, Ill. There it lies across Pennsylvania, Ohio, Indiana, and Illinois, almost to St. Louis, having cost the National Government, in all, $7,500,000, and only waiting for proper improvements to make it a great artery of automobile traffic between Washington and St. Louis, through Columbus, Dayton, Indianapolis, and Terre Haute. And this is but one of the many instances throughout our country where an enlightened national policy, similar to that already adopted in respect to rivers and harbors, would quickly work wonders for the automobile tourist. It is, of course, urged by the rural population that the existing roads are good enough for them. But aside from the fact that the main burden of taxation is borne by the cities desiring to be connected by good roads, the more enlightened of the farming class are beginning to realize the direct utility of the automobile for themselves, and will soon be even more alive to the necessity for good roads than are the tourists.

It behooves every automobilist, through his local club and by keeping in touch with the various good roads associations of the country, to align himself with the movement. The information so gained will more than repay the slight effort and expense involved, and no matter how few times he may tour, he may have occasion, on any one of them, to thank his stars that the users of the car are standing together in a steady demand for conditions that will make its progress throughout the land safe, easy, and comfortable. He must be willing to share

the duties as well as the privileges of the movement, and to make careful notes of road and other conditions whenever on tour he gains, by pleasurable experiences or the reverse, information which it would have been valuable for him to have beforehand.

Apropos of this, let the tourist be warned that much of the success of any trip will depend upon the care with which it has been planned before starting. Information is often meager enough concerning any district in which it is proposed to tour, but the study of routes and the plan of the journey should be made at home, where there is time to think how to avoid undesirable localities, before being actually compelled to go through them or go back. Sticking a road map into the pocket for reference *en route,* and starting out, is not the way to get the most out of touring. Nor can much dependence be placed on the information gathered from those ready-tongued informers of the road, the native inhabitants, who, if they can calculate at all, usually calculate distances from the site of their own homes, often several miles from the point where they are interrogated.

Comparatively few reliable road maps exist, and the tourist should begin to collect and classify systematically all of these he can lay hands on. The Automobile Club of America has done a great deal of good work in issuing reliable route cards and maps of desirable tours, and in organizing tours over different routes for the purpose of ob-

taining exact information of the special kind needed by the automobilist. The courtesy of the club extends to the answering of any inquiries upon which it has data.[1] The tourist and the automobilist in general will find it advantageous to keep in touch with the Automobile Association of America, the national organization of the various clubs throughout the country, founded at Chicago in 1902. Its roll includes, January 16, 1905, forty-one clubs, aggregating a total individual membership of over 4,000. Its permanent Racing Board is the sole recognized authority in the United States for automobile-racing; there are also permanent committees on Law, Highways, and Touring. The objects of the association are stated as follows:

1, The uniting in one national body the automobile clubs of the country, and through them the individual automobilists; 2, the promotion and furthering of all matters of a national character in which automobilists are interested, as follows: *a,* legislative matters; *b,* good roads; *c,* control of racing; 3, providing for its members actual benefits as follows: *a,* reciprocal club privileges; *b,* a bureau which will supply information regarding laws, touring routes, maps, racing statistics, etc.; *c,* a medium for the exchange of ideas, and information of value to clubs in furthering their promotion and usefulness, and of value to individual automobilists.

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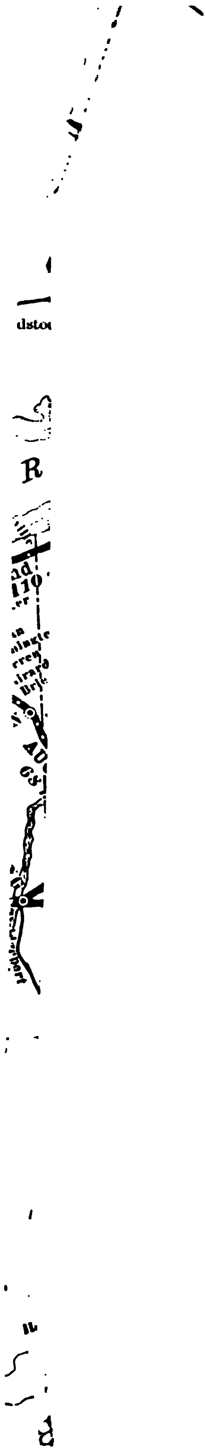
[1] The club may be addressed through its secretary, Plaza Bank Building, New York.



Whether the tourist is a member of the association or not, he should send to the chairman of its Touring Committee [1] any information of value he may pick up in his own wanderings around the country. He will find that his efforts will be met in a broad and gentlemanly spirit by an association of sportsmen whose desire is, like his own, to further the interests of automobilism at large. There is great need for the exchange of reliable information among tourists, and the association furnishes the most ready and effective means for accomplishing this end. Its membership is open to individuals as well as to clubs.

It was under the management of the A. A. A. that a tour to St. Louis was conducted, starting from New York July 25, 1904. The tour was open to non-members and there were no restrictions, those who completed the tour on schedule time receiving the certificate of the association to that effect. There were 110 entries, and eighty of these began the run. Seventy-four of these arrived at St. Louis, August 10th, only three of those who dropped out being prevented by breakdown from going on. The main line of the tour lay along the "northern route" through Buffalo, Cleveland, and Chicago, and provision was made for various contingents to join along the route, as shown on the official map of the tour (facing page 302). This map is valuable as showing two main routes from

[1] The address of the association is 31 West Forty-Second Street, New York.

the East to St. Louis, besides routes from Boston, Baltimore, and Philadelphia, connecting with the main highways westward.

Independently of this tour, but with the sanction of the A. A. A., Mr. F. A. La Roche started from New York City, July 25, 1904, on a non-stop run to St. Louis and back, going by the northern route and returning by the southern over the National Road to Wheeling, thence through Pittsburg and Philadelphia to New York. The car was a 15 to 20 H. P. Darracq, and was driven by Mr. La Roche and his companion, Mr. A. Le Blanc, alternately. Two official observers, Mr. H. H. Everett and Mr. N. N. Mason, were appointed by the A. A. A., and one or the other of these gentlemen was with the car during the entire tour. According to the sworn statements of these watchers, the motor was not stopped from 9.42 A. M., July 25th, till 11.42 A. M., August 9th, on which date the car arrived in New York again, having covered, according to the odometer, 3,450$\frac{3}{5}$ miles, which was somewhat (probably 200 miles) less than the actual distance covered. During the time (two days) the car was in St. Louis it was driven by a mechanic, so as to afford Mr. La Roche and Mr. Le Blanc some rest; the observers, however, kept up their watch. The car made the entire trip without accident, except that a few miles beyond Youngstown, O., about nine o'clock at night, August 5th, the right-hand front spring was broken by the severe fall of the car into a gulley during a terrific thunder-storm. The tourists

were stalled all night on the road, and after making repairs and proceeding twenty miles beyond Chambersburg, Pa., it was discovered that the torsion-rod was broken, having been cracked by the fall above mentioned. A temporary repair was made, and eventually a new rod was substituted when the car reached Philadelphia. Special ferry-boats were chartered to get the car across to Staten Island and thence into New York, as at that time the law, making it obligatory to stop the motor of all automobiles on ferry-boats, had not been repealed. Mr. La Roche died suddenly during March, 1905. He was an enthusiastic automobilist and a thorough gentleman; it is to be regretted that both the sport and the industry have lost so stanch a supporter. After the trip he wrote to Mr. Augustus T. Post, then chairman of the Touring Committee of the A. A. A., as follows: "The greatest caution was used by us in the case of horses, and we showed every regard for pedestrians, teams, domestic animals of all kinds, and at no time did we exceed any of the speed limits of the cities and States we passed through, and it is with great gratification that I write to say that we were received in the most pleasant way by all the farmers, and that no hostility was shown along the entire route. They were always willing to assist us, even at times when we had to wake them up in the early hours of the morning to ask the direction, and we believe we have made many friends for the automobile throughout the country by our consideration for the public."

Several tours across the American continent have been made by individual automobilists, the first being that of Dr. H. Nelson Jackson in a 20 H. P. Winton, starting May 23, 1903, and arriving at New York July 26th. Mr. Thomas Fetch, in a Packard car, started June 20, 1903, from San Francisco, and arrived in New York August 21st. The transcontinental tour of Mr. L. L. Whitman in a Franklin car, already alluded to in Chapter XIII, and the tour of Mr. George A. Wyman on a motorcycle were the transcontinental events of 1904. Accounts of these trips, by the gentlemen who made them, have been published for free distribution by the makers of the cars, and give a fairly good idea of the difficulties encountered and how these were overcome. The so-called "standard route" across the continent was practically taken by Mr. Fetch. It runs from San Francisco to Sacramento, Cal., where the long climb over the Sierra Nevadas begins; then, through hundreds of miles of sand and sage-brush, the route stretches to Salt Lake City, between which and western Nebraska the roads run over mountains and high plateaus. From here to Chicago the route lies through the soft and difficult prairie roads of Iowa and Illinois. From Chicago the favorite course is the northern one, along the lakes, as shown on the map facing page 302. Mr. Fetch took the most difficult route across the Rockies, entering Colorado and reaching the highest point of any of the tours across the continent; namely, on the Continental divide, 11,528

feet above sea-level. Dr. Jackson took a much more northerly route through southeastern Oregon, southern Idaho and Wyoming, thereby escaping the alkali deserts of Nevada, and finding more moderate gradients, but necessitating a somewhat longer mileage. Whichever route is taken, there are hundreds of miles of steep climbs across the Rockies, the stiffest of which is at the very beginning, where, from Sacramento to Summit, Cal., the altitude rises, in a little over 100 miles, from 30 feet to 7,018 feet. The 600 miles from Reno to Ogden over the shifting sands of the alkali desert, where canvas must be spread before the wheels oftentimes to secure traction, are the toughest portion of the journey. On the northern route only small deserts are encountered in Oregon and Idaho. Narrow roads and trails often obliterated, must be made the best of in crossing the Rockies at any point. In southwestern Wyoming there are the Bad Lands with deep washes in sand and gravel, where bridges are often carried away by some quickly gathering storm. Across the Laramie plains of Wyoming the roads are very good, but for miles across the Nebraska plains washouts called "buffalo wallows" make going very slow and difficult. In general the high, rough roads of the mountains give less trouble than the soft, level stretches across the prairies. East of Cheyenne, along the line of the U. P. R. R., through Julesburg, Col., and North Platte, Neb., the old military road is the best stretch east of Sacramento.

The transcontinental tours already taken have done little more for the average automobilist than to spy out the land west of the Missouri. After trying some of the stretches in the real West, the tourist will find such excellent roads as exist in Indiana, for instance, a veritable paradise. California has some exceedingly good roads, many of them oiled with the asphaltic petroleum of the State. The route from Los Angeles to San Francisco along El Camina Real (the old cart road which runs nearly the entire length of the State) is particularly fine. A car in California must be capable of mastering gradients more or less formidable, one of the steepest in the world being found between Gaviota and Santa Ynez, where in fifteen miles there is a steady rise from sea-level to 4,000 feet, the road dipping again to almost sea-level.

The importance to the general automobilist of individual or organized tours is obvious. Not only do they ascertain for him where the good and bad roads are, but they collect information of conditions along the route of the peculiar kind not found in ordinary guide-books. It is important to know the location of repair-shops and garages, and what supplies can be obtained at them. The official Blue Book of the Automobile Club of America contains this information for a considerable number of routes east of Chicago, together with the laws of various States, so far as they apply to the automobile. Roads are described in detail in accordance with an ingenious system, and distances between

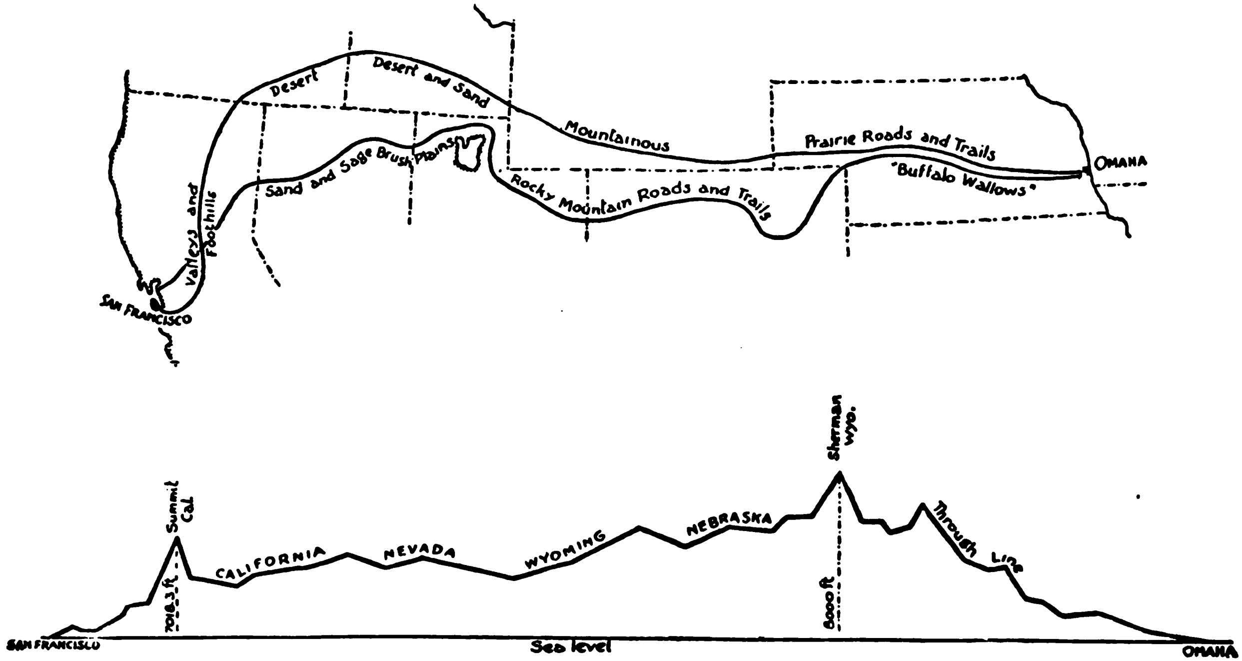


FIG. 148.—The two principal routes across the continent west of the Missouri. The northerly route was taken by Dr. Jackson, and its gradients are shown in the lower diagram. The southerly route was taken by Mr. Fetch.

towns are carefully listed. A similar system is employed on the route cards of the A. A. A., which proposes to increase rapidly the number of routes so described. Where no special automobile maps and route information exists, the tourist must fall back on the ordinary road maps [1] published for various sections, and on the maps of the U. S. Geological Survey. The reports of the U. S. Department of Agriculture also contain information on the progress of road-building in various parts of the country.

The tourist can settle in his mind many questions as to the capabilities of his machine and how it is liable to act under the various conditions of touring, if he will study the reports of the various endurance-runs and reliability-tests which have been held. The English Automobile Club held a 1,000-mile reliability-run in September, 1903, the conditions of which were such as to record a great deal of valuable data. The same organization has planned, for 1905, a 5,000-mile run. The German and the Bavarian Automobile Clubs, in conjunction, hold, August 10 to 16, 1905, a reliability-tour over a course of about 620 miles, from Munich to Baden and Nuremberg, and back to Munich, in competition for the Herkomer trophy. The competition is open to all kinds of machines built and equipped solely for touring. A reliability-run of 572 miles from Sydney to Melbourne, Australia,

[1] Road maps are published by George A. Walker & Co., Boston, Mass., and C. S. Mendenhall, 512 Race Street, Cincinnati, O.

was held February 21 to 25, 1905, under the auspices of the Dunlop Tire Company. Sometime previous to this a run was held in India from Delhi to Bombay, 281 miles, by the India East Coast Automobile Association.

The American touring contest of 1905 is that for the Glidden Cup, under the management of the A. A. A. The course will extend over 1,000 miles in New England, and great care will be taken to observe the running conditions of each car. Mr. C. J. Glidden, the donor of the trophy, is himself engaged in making a tour of the world in an automobile, accompanied by his wife. Upon arrival at Sydney, Australia, March 11, 1905, Mr. Glidden had completed 23,247 miles in 195 days' actual running, having been the first to cross the Arctic Circle in an automobile, August 16, 1903. He is to arrive in New York June 24, 1905, to take part in the New England tour. The remainder of his tour, as planned by Mr. Glidden, will take about three years. The expenses of the trip average about thirty dollars a day.

As to the methods and paraphernalia of touring, it is possible to give the inexperienced any quantity of advice, good, bad, and indifferent. A man of average intelligence, who proposes a tour, will work out some system of his own, which will more or less correctly fit his case, and will be modified by experience. The experience of others is suggestive rather than final. The tendency of the novice is undoubtedly to take too much, rather than too lit-

tle, on the car. Personal baggage should be kept down to a minimum and as much of it as possible shipped ahead, to points where it will be needed. The first care must be to provide space on the car for vital parts of the power and running equipment, which, if broken, could not be replaced *en route*. Motor, carbureter, and ignition parts are of prime importance, while carriage-bolts and nuts are generally easy to obtain in populated districts. What shall be taken and what shall be left depend, in the case of each tour, on the locality to be covered and the nature of the driving. In rough country it is highly advisable to take a block and tackle and *two* jacks as well as a rubber cover for the machine. This last is very desirable on any tour where there is no certainty of being able to secure some kind of shelter for the machine in bad weather and at night. A rubber storm-apron covering the driver and the mechanism, with aperture for the driver's head, suggests itself for use on an open car in a tour of any length. With two jacks the car may be pried out of a hole where one jack would not raise it high enough for the block and fall to prove effective. If there is to be driving through soft, muddy roads, one of the various tire attachments for securing traction is positively essential. An improvised device is to wrap rope around the tires, but the chains sold for this purpose are quickly put on, last longest, and afford the maximum comfort under the conditions. The adventurous tourist, who is fond of life in the open,

may combine camping with his trip by taking along one of the light army tents accommodating two people. A light and compact culinary outfit may be made up of aluminum ware. Many other "wrinkles" and methods of getting pleasure out of the automobile will be adopted or originated by the enthusiastic tourist—and which of them will not become enthusiastic! "Touring by automobile," says Mr. Augustus T. Post, "is like deep-sea sailing in a yacht. Just as you never know the sea till you are out upon it, dependent solely on your own resources and on the stanch craft beneath you, so you never really know the land, till you cruise along the open road, away from all the devices of man except the wonderful one which carries you; and the more you grow to know it and to find whither it will lead you, the more you grow to love it."

The following apt remarks by Mr. Percy F. Megargle, who has twice made the trip from New York to St. Louis and back, about 6,000 miles, and who, on the first occasion, started out without any previous experience of long-distance driving, contain some sound advice:

"To tour with genuine enjoyment, comfort, and enthusiasm, a happy medium should be used in all things. In the first place, do not start out with too large a machine, for if you do, and get stuck, it will take several horses and as many men to get you out. Again, if your machine is too small, it will not have power enough to carry you up the mountains, bound to be encountered on a long tour, and will be so near the ground that mud will prove troublesome. To be on the safe side,

therefore, get a machine of medium size, medium weight, and medium power.

"In providing your outfit strike a medium again. You could carry a load of supplies and equipment, weighing several hundred pounds, without half trying, or, again, take so few things that you would come to grief along the road somewhere—of course when you least expect it.

"There are several things of vital importance in an equipment, and I will name them briefly. Some of them will look strange to the club-house automobilist, who runs his machine over good pavements in fine weather, but they may come in mighty handy when you are stranded miles from the nearest village and nearly that distance from the nearest house.

"In the first place, fit an extra gasoline-tank somewhere about your machine, one that will hold at least two gallons of that precious fluid. There are a thousand and one things that may happen to your main tank. It may run dry through inattention, it may leak, it may be filled with kerosene through mistake, and you may need that extra supply for divers reasons.

"When you've looked after your gasoline, give the tire question a little careful consideration, and don't forget *that pump*—the pump that will work as intended every time. If your tires are practically new when you start out, one extra outer casing and two or three inner tubes should prove sufficient. Carry patching-rubber along with you, but bear in mind it is impossible to do anything more than make a temporary repair job to an inner tube during hot weather, because no patch will hold unless it is vulcanized. If your car is equipped with clincher tires, don't forget the tire irons. On my first New York-St. Louis automobile tour in the 'Elmore Pathfinder,' I ran our car 3,000 miles without a puncture. On the second [illegible] I punctured four times the first day.

"Other articles I would strongly advise every tourist to [illegible] in his kit are a large tin pail, single and double wood [illegible] with 50 yards of good strong rope, spade, jack, gallon [illegible] cylinder oil, good gas search-light mounted on swivel [illegible] sign-boards at night as well as picking out the [illegible] copper wire, two or three feet of small hose same [illegible] radiator pipes, and a complete set of tools, with [illegible] duplicate steering-knuckle, extra chain, and such [illegible] and screws as the factory will suggest.

XV

DIFFICULTIES OF THE ROAD.

Fording a stream and plowing through a Kansas road on Mr. Megargle's tour from New York to St. Louis.

"Tourists should be well provided for rainy weather and should carry goggles. From 4 A.M. to 8 A.M., and from 4 P.M. until 9 P.M., are the hours known as 'fly time,' especially in the country, and it is positively necessary to wear goggles during those hours to protect the eyes from insects.

"On the road, treat every horseman encountered with the same respect you would a member of your own family, and take it for granted every horse you meet is going to be frightened until he has proved differently. In this way you gain the friendship instead of the enmity of the ruralities, and avoid any chance of being held for manslaughter, through some accident resulting from a runaway.

"In case of a runaway or other accident, always stop and render such assistance as lies within your power. Do this for two reasons: You should be man enough to do so; if you are not, remember that all small country places are connected with each other by rural telephones and the constables and sheriffs get fees for all arrests they make. If you are arrested, it will go much easier with you if you have already made such restoration as lay within your power; while, if brought back by an officer after having tried to escape, things will go pretty hard with you. In my 6,000-mile cruise in the 'Pathfinder' last summer, I was never arrested, never paid a cent for damages caused, and although indirectly responsible for several bad smash-ups in different States traversed, the injured parties are among my best friends to-day.

"And now a few words on the care of the machine used. The first thing to bear in mind is: *Keep every bearing well oiled.* The machine I used on my two trips last summer was oiled at least four times a day. I do not mean every part of the machine, but such as needed oil. That sounds ridiculous, even to the manufacturer, but that machine carried me 6,000 miles without a break, without a worn-out bearing, and is to-day in as good condition as when I left New York last May. In figuring up what it had done after my trip, I made out that the fly-wheel had revolved some 42,000,000 times, and that the two cylinders had exploded some 84,000,000 times. Each wheel had revolved at least 5,000,000 times, and, as I said before, proper oiling allowed the machinery to do all this without showing any effect of hard usage."

APPENDIX

I

AUTOMOBILE LEGISLATION

PORTION OF AN ADDRESS BY WINTHROP E. SCARRITT, EX-PRESIDENT OF THE AUTOMOBILE CLUB OF AMERICA, BEFORE THE CLUB, FEBRUARY 7, 1905

As automobilists, we have rights on the road. But these rights involve duties and responsibilities to other users of the highway.

A few automobilists misuse their rights and run recklessly over the rights of others. But the abuse of a thing is no argument against its legitimate use. We suffer for the sins of a few. The tension between the public and the motorist grows tighter with every accident upon the highways.

Disaster, which it will take years to remedy, will result unless the responsible users will themselves undertake to control the irresponsible users, and that very soon responsible gentlemen do not make the operation of their cars a menace to life and limbs upon the public highway. Ninety per cent of the trouble arises out of the fact that respon-

sible gentlemen allow irresponsible chauffeurs to run amuck, frightening people out of their wits, and leaving a trail of blue smoke and profanity in the wake of their cars. Some chauffeurs are careful and considerate, but most of them are a law unto themselves. It is quite possible for owners to stop all this. As long as reprehensible behavior is permitted, odium will rest upon the sport as a whole.

It is a grave question whether any special automobile legislation is constitutional.

Why should we be singled out of the community and, *nolens volens,* put into the criminal class with a conspicuous number attached to our vehicles? The motorphobiac replies—you put yourselves in the criminal class when you drive your car in excess of the legal limit.

Accurate records taken in Central Park, Riverside Drive, and Fifth Avenue, in this city, showed that every one of four hundred and thirty-seven horse-drawn vehicles exceeded the speed limit, and not a single arrest was made. Why should the law be enforced against one class of citizens and the same law be entirely ignored as to another class? Ordinarily, under our system of government, an accused man is supposed to be innocent until he has been proved guilty. The exception to that rule is the automobilist. If an automobilist is arrested, the whole machinery of the law, from the officer making the arrest to the last court of appeal, apparently presupposes the man to be guilty, and he must prove his innocence or suffer the conse-

quences. Gentlemen of highest business character, whose word would be taken anywhere else under any circumstances at full value, are put under immediate suspicion when arrested for a supposed violation of the automobile law, and the word of any petty, prejudiced officer is allowed to offset their sworn statements.

However, in the present condition of the public mind, perhaps it is quite as well that we should have legislation and endure certain evils rather than fly to those we know not of.

I take it that the object of sound legislation is to protect the public, and yet not be so drastic that it will retard the development of this new and important industry. Such a law must be definite in its provisions, easily understood, and the penalties must fit the offense. Such a law must be fair, so that it will have back of it the power of public sentiment.

I will now suggest what I regard as the most important provision of such a law. First, I must say that experienced automobilists who are fair and open-minded are far better qualified to draft such a law, one that will be practical in its workings, than those who know nothing of the automobile. This is self-evident.

Analyzing the situation, we find that 90 per cent of the automobilists are careful in the use of their cars on the public highways, and such need not the restraining influence of any law. The 10 per cent who bring us all into disrepute are composed, for

the most part, of two classes: First, the rich, reckless driver, to whom the imposition of a fine is no hardship; and, second, the *reckless*, dare-devil, harum-scarum chauffeur, who seems to delight in seeing how reckless and spectacular he can be in the use of his car. Therefore, no law will ever be effective that does not have special regard to these two classes of offenders. Public sentiment will not justify locking these men up for a first offense, where no actual damage has resulted. A fine is paid and forgotten five minutes afterward. How, then, are these two classes of flagrant violators to be reached? I believe that the result may be obtained by a revocable license.

First: Let every driver of a car receive a certificate or license from the Secretary of State. On conviction, in addition to other penalties, for a first offense, let the certificate be revoked for a period of fifteen days, the trial magistrate indorsing on the certificate such revocation; for a second offense, a revocation of thirty days; for a third offense, a revocation for one year. For the rich owner to be deprived of the use of his car in this way would be humiliating, indeed. Every driver of a motor-car realizes the chief pleasure of motoring is in driving one's own car. The rich culprit would be exceedingly careful not to lay himself liable to a second or a third conviction. In the case of a conviction of a reckless chauffeur, he would be out of employment and his means of livelihood be taken from him, so that he, the most prolific source of trouble,

would have strong reasons for not getting into difficulty. The sentiment of the entire community would back up such a law as this.

Second: Public garages should be under the supervision of the law.

a. They should be required to take out a license.

b. To keep a record of each machine, showing the exact time it was taken out and the exact time it was brought back.

c. The duplicate of this record should be furnished the owner of the car once a week.

d. To allow no machine to go out without written order from the owner.

Third: Concerning Chauffeurs: The following requirements:

a. To take out a license.

b. To keep a record of the car when it leaves and when it returns to the garage.

c. To notify the owner of the car immediately when it becomes disabled.

Fourth: All cars above 5 horse-power should be required to have two separate brakes, one of which should be double-acting.

Fifth: No car should be permitted to run with the muffler open in the corporate limits of a village, town, or city.

Sixth: The speed within corporate limits should be twelve miles an hour, except in thinly populated sections, where eighteen miles per hour should be permitted, and thirty miles per hour in the open country. But no speed should be allowed greater

than is safe and consistent with conditions of traffic on the highway. These, in the main, would, I take it, be the general provisions of a sane and sensible law; one that in its practical workings would, if fairly and honestly enforced, protect the public and do no violence to the new industry.

II

RACING RULES

The American Automobile Association, embracing in its membership the principal automobile clubs of the United States, was formed in March, 1902, one of its functions being to regulate and control automobile racing in the United States. All authorized race meets in the United States are now held upon sanction from and under the Racing Rules of that Association.

GORDON BENNETT CUP RULES

AUTOMOBILE CLUB OF FRANCE

SOCIETY FOR THE ADVANCEMENT OF AUTOMOBILES,

6 PLACE DE LA CONCORDE, PARIS

RULES FOR THE GORDON BENNETT CUP

(*Liberal Translation*)

Note.—The term "Holding Club" is used in these rules to designate the Club which is the actual custodian of the Gordon Bennett Cup.

The Automobile Club of France is the guardian of a cup donated by Mr. Gordon Bennett, which is

intended as an international challenge trophy. It shall be competed for under the following conditions:

I

Every foreign Automobile Club recognized by the Automobile Club of France is entitled to challenge for the cup and to dispute the possession of it with the Holding Club.

II

The clubs recognized are: The Automobile Club of Belgium; the Automobile Club of Austria; the Swiss Automobile Club; the Automobile Club of Turin; the Automobile Club of Great Britain and Ireland; the Automobile Club of Germany, and the Automobile Club of America.

Any Club not mentioned in this list, desiring to be added thereto, must be accepted by a majority of the above-named Clubs, providing this majority include the one or more Clubs of the same country already recognized. Its name will then be added to the list and it will enjoy all the privileges of the recognized Clubs.

It is, nevertheless, well understood that on the motion of one Club, duly carried, any Club may be struck off this list.

III

Every qualified Club wishing to challenge the Holding Club for the cup shall notify the latter of

its intention before the first day of January in each year, by registered letter addressed to its President, and shall state the number of vehicles which will take part in the race. It shall also deposit with the Holding Club the sum of Three Thousand Francs. This sum shall be refunded if one of its representatives presents himself at the start. The President of the Automobile Club of France, even though his Club does not take part in the race, shall always be informed by registered letter.

IV

Each Club may be represented by one, two, or three vehicles, at its option, but the fact of its using but one or two shall not debar the other Clubs from exercising the right to use three.

If two or more clubs of the same country should be admitted to the list of recognized Clubs, it is well understood that that country can be represented by no more than three vehicles all told.

The Clubs of the same country shall in such a case have to agree among themselves which of their vehicles shall take part in the race. In case of a disagreement, the vehicles shall be chosen in the order of entry.

V

The Cup may be competed for every year between the fifteenth day of May and the fifteenth day of August.

The exact date shall be determined by mutual agreement of the interested Clubs before the first day of February in every year.

VI

In the case of the Holding Club receiving challenges from several Clubs in due time, there shall be but one race wherein the challenging Clubs and the Holding Club shall be represented by not more than three vehicles each.

VII

Vehicles qualified to compete must conform to the definition of the vehicle, as given in the Racing Rules of the Automobile Club of France, to wit:

The carriage shall weigh at least 400 kilos and not more than 1,000 kilos, and shall carry at least two passengers, side by side, of an average minimum weight of sixty kilos each, it being understood that in case the average weight of the passenger should not amount to sixty kilos, the balance shall be made up by ballast.

The carriage shall be weighed empty. By empty is meant without passengers or supplies (coal, petroleum, water, accumulators) and without tools or extra pieces, or baggage, dress, or provisions.

Carriages which generate the necessary energy for lighting purposes from a mechanical device run by their motors shall be given an allowance of

seven kilos. The weight of the lanterns and horns is not comprised in the weight of the vehicles, but only that of the lantern-holders.

VIII

The carriages in each and every one of their parts shall be entirely constructed in the country of the Clubs which they represent.

IX

The carriages shall be operated by drivers appointed by the Competing Clubs. Their two seats shall be occupied during the entire duration of the Race.

X

A Commission shall act for the enforcement of these rules. Each competing Club shall nominate a delegate. Mr. Gordon Bennett shall always be an *ex-officio* member of this Commission. The Automobile Club of France, even though it does not take part in the race, shall also *ex-officio* be represented by a delegate in the Commission.

The delegates shall name outside of their own number a President, who, in case of a tie vote, shall cast the deciding ballot. If the delegates should not be able to agree upon the choice of a President, then he shall be appointed *ex-officio* by Mr. Gordon Bennett, or in his default, by the President of the Automobile Club of France.

The Commission shall appoint a starter, an umpire at the finish, and timekeepers. They shall

not be bound to select such officers from among their own number.

The Commission is charged with the duty of enforcing strictly these rules and of passing upon and deciding all incidents which may occur.

The race shall be confirmed by this Commission.

XI

The race shall be held on a road, in a single stage, of a distance not less than five hundred and fifty kilometers (550 km.), and not more than six hundred and fifty kilometers (650 km.). This distance may be taken from one city to another, or may be divided into several round trips, each partial trip to be not less than one hundred and twenty-five kilometers.

The Holding Club shall choose the route; it shall make the same known in an exact and detailed manner by registered mail to the Challenging Clubs at least three months before the date fixed for the race.

If, after such notification, a change of itinerary should be made, the same shall be communicated at once by registered mail to the competing Clubs. No such change shall be permitted except in case of absolute necessity and only after receiving the approval of the Commission provided for by Article X hereof.

XII

The race shall be run in the country where the Cup is held.

The Holding Club, however, shall always have the right to run the race in France.

XIII

Starting shall be at intervals of two minutes. The order shall be as follows: First a carriage of the team of the Holding Club; then a carriage of each of the teams of the contesting Clubs, beginning with the Club whose challenge was first received: then the second carriage of the Holding Club, followed in the same order by the second carriages of the other Clubs. Finally the third carriages in the same order.

XIV

The carriage which shall cover the distance in the shortest time shall be declared the winner, and shall win the Cup for its Club, even though it be the only one of its team to finish the course.

XV

In case of a dead-heat between the Holding Club and one of the challenging Clubs, the Holding Club shall keep the Cup.

XVI

In case of a dead-heat between two challenging Clubs for the first place, they shall race over again, under these rules, within a period of two months, it being understood that the end of such period may be later than provided for by Article V hereof.

In case the two Clubs should not be able to agree for the choice of the route, they shall draw lots.

Should one of the Clubs refuse to run again, the other Club shall *ipso facto* become the holder of the Cup.

XVII

Within fifteen days after the confirmation of the race, the Cup shall be handed over to the custody of the winner. In case of a dead-heat and pending the running off of the same, the Cup shall remain in the custody of the Holding Club.

XVIII

If one of the challenging Clubs should be alone represented at the start, it shall cover the whole course within a maximum time to be fixed by the Commission provided for by Article X hereof. A failure to do so shall entitle the Holding Club to keep the Cup.

XIX

It is well understood that no Club shall ever become the owner of the Cup; it may only be the HOLDER thereof, subject to these rules.

XX

In case the Holding Club should cease to exist, the Cup shall be handed over to Mr. Gordon Bennett, or in his default, to the Automobile Club of France.

APPENDIX

XXI

The races for the Cup, whether they take place in France or in another country, shall always be subject to the Racing Rules of the Automobile Club of France.

XXII

The expenses for the transportation of the carriages and of their equipments, for combustibles, etc., shall be borne by the owners of the vehicles or by the Clubs which they represent.

XXIII

The traveling expenses of the members of the Commission provided for by Article X hereof shall be borne by the Clubs which they represent.

The expenses for the organization of the race itself (compensation and traveling expenses of timekeepers, posters, tips along the course, etc.) shall be disbursed by the Holding Club. After the race they shall be divided equally between the Holding and the challenging Clubs. It is agreed that the sums due from the challenging Clubs which did not take part in the race (and which thereby have forfeited to the Holding Club the Three Thousand Francs named in Article III hereof) shall be paid by the Holding Club.

XXIV

All Clubs, whether holding the Cup or challenging for it, thereby agree absolutely to conform strictly to all the Articles of these Rules and in

cases not herein provided for, to conform to all the Articles of the Road Racing Rules of the Automobile Club of France.

III

EVENTS OF THE ORMOND—DAYTONA TOURNAMENT HELD AT ORMOND, FLA., JANUARY 23-28, 1905

1. One hundred miles. International. For the W. K. Vanderbilt, Jr., trophy.
2. One mile. International Championship. For the Sir Thomas Dewar challenge trophy.

   No more than four cars will be run in a heat; a second round of heats will be run, if necessary. The winner of each heat (or second round of heats, as the case may be) and the fastest second car to compete in the final. Further conditions as specified in deed of gift.
3. One mile. Time trials. Classes A, B, and C. (Class A, 1,432 to 2,204 pounds; B, 851 to 1,432 pounds; C, 551 to 851 pounds.)
4. One kilometer. Time Trials. Classes A, B, and C. (Class A, 1,432 to 2,204 pounds; B, 851 to 1,432 pounds; C, 551 to 851 pounds.)
5. Ten miles. Ormond Derby, Open. For the Major C. J. S. Miller trophy.
6. Fifty miles. Daytona Handicap, Open. For the F. E. C. A. A. challenge cup.

   Conditions as specified in deed of gift.

7. One kilometer. Record Race, Open. For the H. L. Bowden trophy.
8. One mile. Steam cars. For the Colonel R. C. Clowry trophy.
9. One mile. Corinthian. Amateur owners only to drive. For the Colonel L. C. Weir cup.
10. Fifty miles. Open to American-built cars only. For the Lozier trophy.
11. Ten miles. Mercedes cars only. For the Allen-Halle trophy.
12. Ten miles. F. I. A. T. cars only. For the Hollender & Tangema cup.
13. Twenty miles. For the E. R. Thomas championship trophy.
14. Five miles. Stock cars. Catalogue prices from $1,001 to $1,800, inclusive.
15. Five miles. Stock cars. Catalogue prices from $1,801 to $2,750, inclusive.
16. Five miles. Stock cars. Catalogue prices from $2,751 to $4,000, inclusive.
17. Five miles. Handicap. Open only to the first four cars in events Nos. 14, 15, and 16.
18. Five miles. Stock cars. Catalogue prices from $4,001 to $6,000, inclusive.
19. Five miles. Stock cars. Catalogue prices from $6,001 to $8,000, inclusive.
20. Five miles. Stock cars. Catalogue prices from $8,001 to $10,000, inclusive.
21. Five miles. Open. For the W. Gould Brokaw trophy.

22. Five miles. Great Ormond Handicap.

    Open only to the first three cars in events Nos. 18, 19, 20, 21. Cars to compete in exactly the same condition as in events Nos. 18 to 21, inclusive. No fee.

23. Five miles. Gasoline stock cars. Catalogue prices $650 and under.
24. Five miles. Stock cars. Catalogue prices from $651 to $1,000, inclusive.
25. Ten miles. Stock cars. Catalogue prices from $1,001 to $1,800, inclusive.
26. Ten miles. Stock cars. Catalogue prices from $1,801 to $2,750, inclusive.
27. Ten miles. Stock cars. Catalogue prices from $2,751 to $4,000, inclusive.
28. One mile. Time Trials. Stock cars. Price classification as in above events.
29. Ten miles. Handicap. Open.
30. One kilometer. Class A. Open only to vehicles weighing 1,432 to 2,204 pounds.
31. One kilometer. Class B. Open only to vehicles weighing 851 to 1,432 pounds.
32. One kilometer. Class C. Open only to vehicles weighing 531 to 851 pounds.
33. One mile. Class A. Open only to vehicles weighing 1,432 to 2,204 pounds.
34. One mile. Class B. Open only to vehicles weighing 851 to 1,432 pounds.
35. One mile. Class C. Open only to vehicles weighing 551 to 851 pounds.
36. Gymkhana Race.

IV.

BRAKE TESTS. AUTOMOBILE CLUB OF AMERICA, MAY 1, 1902.

CAR.	Weight in lbs.	Speed under 10 mile limit.	Stopped in	Speed under 17 mile limit.	Stopped in	Speed under 20 mile limit.	Stopped in	Speed (no limit).	Stopped in
			ft. in.		ft. in.		ft. in.		ft. in.
Oldsmobile	1,800	8.7	8 9	14.4	21 7	20.0	60 6	20.0	58 6
Pierce	650	12.4	22 9	13.8	24 1	....	.....	....	......
White (steam)	1,350	10.0	17 2	15.0	31 0	....	.....	....	......
Locomobile (steam)	1,000	7.8	5 9	16.3	30 9	22.5	51 5	32.5	139
Auto-car	1,050	8.0	9 10	14.4	31 8	20.0	69 3	....	......
Waverley (electric)	1,050	8.7	4 4	13.8	21 5	....	.....	....	......
Toledo (steam)	1,400	7.6	4 6	12.8	15 2	27.0	45 8	27.6	123 1
Panhard	2,000	9.4	5 11	16.3	25 4	18.9	34 6	25.7	89 7
Gasmobile	2,100	9.2	10 0	12.0	9 10	20.0	35 0	27.6	114 7
Peugeot	1,920	6.4	4 2	15.6	40 10	....	.....	....	......
Riker (electric)	1,500	9.4	29 6	11.2	43 5	....	.....	....	......
Packhard	2,500	7.2	6 8	13.3	26 7	....	.....	....	......
Peerless	1,700	14.4	39 3	....	.....	....	.....	....	......
Long Distance	1,400	11.6	17 3	....	.....	18.9	29 2	21.1	60 5
Friedman	900	6.9	7 0	8.3	10 4	17.1	57 9	....	......
Haynes-Apperson	2,000	4.5	4 6	13.8	21 2½	....	.....	....	......
Mors	.....	.....	.....	....	.....	22.5	75 9	30.0	125 8
Four-horse Coach	.....	.....	.....	16.3	77 6	....	.....	....	......
Victoria and pair	.....	.....	.....	13.8	36 10	....	.....	....	......
Bicycle	.....	9.4	8	....	.....	20.0	61 6	27.6	131 2

BRAKE TESTS. PHILADELPHIA, U. S. A., JUNE 24, 1902.

Car.	Weight in lbs.	Speed in miles per hour (no limit).	Stopped in ft.	in.
Locomobile (steam)	1,200	27.5	71	0
Columbia (electric)	2,700	17.25	40	6
Oldsmobile (steam)	950	21.0	88	0
Auto-car	1,400	19.5	59	8
"	1,400	21.5	62	8
Winton	2,000	23.5	56	5
Mercedes	2,300	25.5	68	2
Packard	2,000	19.75	42	8
Columbia (electric)	2,700	12.0	12	7
Panhard	3,000	27.57	74	0
Mors	2,200	8.0	7	3
"	2,200	13.0	10	1
"	2,200	17.5	22	0
"	2,200	18.5	25	2
"	2,200	21.5	40	0
"	2,200	30.0	91	3
Runabout (electric)	1,000	14.5	30	4
Auto-car	1,400	24.0	50	10
Trotting Team	.....	21.5	61	0
Four-in-hand	.....	17.25	62	8
Bicycle	.....	25.0	185	0

[redacted]

GLOSSARY

ENGLISH—FRENCH—GERMAN

Gender of nouns indicated by m=masculine; f=feminine; n=neuter

A

Accessories. *F.* accessoires (m). *G.* Zubehör (n).

Accumulator Charging. *F.* Mise à charge des accumulateurs. *G.* Ladung (f), Laden (n) der Akkumulatoren; **charging station,** *F.* station de charge (f). *G.* Ladestation (f) für Akkumulatoren; **to discharge an,** *F.* décharger un accumulateur. *G.* einen Akkumulator entladen; **efficiency of the,** *F.* accumulateur (m), rendement de l'. *G.* Nutzeffekt (n) des accumulators; **plate of the,** *F.* accumulateur (m), plaque de l'. *G.* Platte (f).

Accumulators. *F.* accumulateur (m). *G.* Akkumulatoren (m); sekundärelement (n); Sammler (m).

Adjust, to. *F.* adapter. *G.* anpassen; *F.* ajuster. *G.* einrichten.

Admission-pipe. *F.* tuyau (m) d'entrée. *G.* Eintrittsrohr (n).

Air-tight. *F.* hermétique. *G.* hermetisch.

Air-tube. *F.* tube (m) d'air. *G.* Luftröhre (f).

Ampere-hour. *F.* ampère-heure (f). *G.* ampère-stunde (f). (*See* ACCUMULATOR CHARGING.)

Angle-iron. *F.* cornière (f). *G.* Eckschiene (f).

Armature. *F.* armature (f). *G.* Anker (m); **drum,** *F.* armature (f) en cylindre. *G.* Trommelanker (m); **shuttle,** *F.* armature (f) de Siemens. *G.* Siemensanker (m).

Automobile. *F.* automobile (m). *G.* Auto-mobil (n); Auto-mobil (m).

Automobilism. *F.* automobilisme (m). *G.* Automobilismus (m).

Automobilist. *F.* automobiliste (m). *G.* Automobilist (m). *F.* chauffeuse (f). *G.* Führerin (f).

B

Back-fire. *F.* contre-coup (m).

Backlash. *F.* jeu (m) de dents. *G.* Spielraum (m).

Bandage. *F.* lien (m). *G.* Band (n). The French word "bandage" means a tire.

Batteries, primary. *F.* pile (f) primaire. *G.* Primärelement (n).

Battery, secondary. *F.* pile (f) secondaire. *G.* Sekundärbatterie (f). (*See* ACCUMULATORS); **to maintain.** *F.* entretenir une pile. *G.* eine Batterie unterhalten (Speisin).

Bearing. *F.* chaise (f); chaise pour paliers. *G.* Lager (n); Lagerblock; **hot,** *F.* coussinet (m) échauffé. *G.* warmlaufende Lager (n); **main,** *F.* palier (m) de l'arbre de couche. *G.* Hauptlager (n); **surface,** *F.* surface (f) de palier. *G.* Lagerfläche (f); **thrust,** *F.* palier (m) de buttée. *G.* Drucklager (n).

Bearings, ball, *F.* chaise à billes. *G.* Kugellager (n); **balls for,** *F.* bille (f). *G.* Kugelzapfen (m); **roller,** *F.* chaise à rouleaux. *G.* Rollelager (n).

Bell. *F.* Sonnette (f). *G.* Glockenschale (f); Glocke (f).

Bend. *F.* recourber. *G.* umbiegen. *F.* plier. *G.* beigen. *F.* recourber. *G.* umbiegen.

Benzene. *F.* essence (f) de pétrole. *G.* Benzin (n). *F.* benzine (f).

Blow-off Pipe. *F.* tuyau (m) de purge. *G.* Abblaserohr (n).

Blow out, to. *F.* nettoyer. *G.* ausblasen.

Boiler, cylindrical. *F.* chaudière (f) cylindrique. *G.* Cylinderdampfkessel (m); **fittings,** *F.* garniture (f) d'une chaudière à vapeur. *G.* Kesselarmatur (f); Kesselzubehör (n); **plate, overheating of the.** *F.* surchauffage (m). *G.* Ueberhitzung (f) der Platten; **stay,** *F.* ancre (f) d'une chaudière à vapeur. *G.* Kesselanker (m). *F.* contrefiches (f) *G.* Kesselbolzen (m).

Boiler Test. *F.* épreuve (f) des chaudières. *G.* Kesselprobe (f); **to scale,** *F.* enlever des dépôts d'une chaudière. *G.* Kesselstien (m). **tube,** *F.* tube (m) bouillieur; tube (m) de chaudière. *G.* Siederohr (n); Kesselrohr (n).

Bolt, holding down. *F.* boulon (m) de fondation. *G.* Fundamentbolzen (m); **screw,** *F.* boulon (m) à vis. *G.* Schraubenbolzen (m); **set,** *F.* boulon (m) à tête. *G.* Kopfbolzen (m).

Bore and Stroke. *F.* alésage (m) du cylindre = bore of the cylinder; course du piston (f) = stroke of the piston. *G.* Bohrung (f) = bore; Weg (m) des Kolbens = stroke of the piston.

Brake. *F.* frein (m). *G.* Bremse (f); **band,** *F.* frein (m) à ruban. *G.* Bandbremse (f); **block,** *F.* sabot (m) de frein. *G.* Bremsklotz (m); **foot,** *F.* frein (m) à pédale. *G.* Fussbremse (f); **hand,** *F.* frein (m) à levier. *G.* Handbremse (f); **rim,** *F.* frein (m) à couronne. *G.* Kranzbremse (f); **rod,** *F.* tige (f) du frein. *G.* Bremsstange (f).

Brake, to. *F.* serrer le frein. *G.* bremsen.

Brass, sheet. *F.* laiton (m) en lames. *G.* Messingblech (n);

tube, *F.* tube (m) en laiton. *G.* Messingrohr (n).

Breakdown. *F.* Panne (f). *G.* Klemme (f) Betriebstörung.

Brush holder. *F.* porte-balais (m). *G.* Burstenhalter (m).

Buffer, india-rubber. *F.* tampon (m) a rondelles de caoutchouc. *G.* Kautschukbuffer (m); Gummibuffer (m).

Burner, gas. *F.* bec (m) à gaz. *G.* Gasbrenner (m).

Bushes, brass. *F.* coussinets (m) de bronze. *G.* Metallagerschalen (f).

C

Cam. *F.* came (f). *G.* Daumen (m); Nocke (f); **exhaust,** *F.* came (f) d'échappement. *G.* Nockenrad (n) für die Auspuffsteuerung; **gear,** *F.* distribution (f) à came. *G.* Daumensteuerung (f); Nockensteuerung (f); **head,** *F.* rebord (m) saillant. *G.* Knagge (f); **ignition,** *F.* came (f) d'allumage. *G.* Unterbrecherschiebe (f); **inlet,** *F.* came (f); distribution (f) d'introduction. *G.* Einlafssteuerung (f). (*See* CAM.); **shaft,** *F.* arbre (m) à cames; bague (f) à cames. *G.* Daumenwelle (f).

Cap. *F.* capotte (m) chapeau (f). *G.* Mütze (f) Kappe (f).

Capacity. *F.* capacité (f). *G.* Leistungsfähigheit (f).

Carbureter. *F.* carburateur (m). *G.* Karburator (m).

Carriage Work. *F.* carrosserie (f). *G.* Wagenarbeit (m).

Casing. *F.* enveloppe (f). *G.* Hülle (f); **for gear,** *F.* carter (m). *G.* Gehäuse (n).

Castings, steel. *F.* jet (m) d'acier. *G.* Stahlgufs (m).

Caulk, to. *F.* boucher. *G.* abdichten.

Cells, dry. *F.* piles sèches (f). *G.* trockene Elemente (f).

Cement. *F.* lut (m). *G.* Kitt (m); **to,** *F.* luter, coller, mastigner. *G.* rerkitton.

Center-bit. *F.* mèche (f) anglaise. *G.* Centrumbohrer (m).

Chain. *F.* chaine (f). *G.* Kette (f); **link,** *F.* chainon (m), anneau (m) de chaine. *G.* Glied (n); Gelenk (n).

Chisel, cold. *F.* tranche (f) à froid. *G.* Kaltmeissel (m).

Circuit, put in. *F.* mettre dans le circuit. *G.* einschalten; **to close the,** *F.* circuit (m), fermer le. *G.* Stromkreis (m) schliessen; **to open the,** *F.* circuit (m), couper le. *G.* Stromkreis (m) öffnen; **to put out of,** *F.* mettre hors du circuit. *G.* ausschalten.

Clutch, friction. *F.* accouplement (m) à Embrayage. *G.* Reibungskupplung (f); **friction cone,** *F.* cône (m) de friction. *G.* Friktionskonus (m); Reibungskonus (m); **toothed,** *F.* manchon (m) à griffes. *G.* Klauenkupplung (f).

Cock, bib. *F.* robinet (m) de vidange. *G.* Schnauzhahn (m); **blow-off,** *F.* robinet (m) de vidange. *G.* Ablasshahn (m); **discharge,** *F.* robinet (m) de décharge. *G.* Abflusshahn (m); **gauge,** *F.* robinet (m) indicateur. *G.* Wasserstandshahn (m); **lubricator,** *F.* robinet (m) à graisse. *G.* Schmierhahn (m); **pet,** *F.* robinet (m) de cylindre. *G.* Zylinderabblasshahn (m); **steam,** *F.* robinet (m) à vapeur. *G.* Dampfabblasshahn (m); **stop,** *F.* robinet (m) d'arrêt. *G.* Absperrhahn (m); **two-way,** *F.* robinet (m) à deux orifices. *G.* Zweiwegehahn (m); **water,** *F.* robinet (m) à eau. *G.* Wasserhahn (m).

Cog-tooth. *F.* alluchon (m). *G.* Zahn (m).

Coil, induction. *F.* bobine (f) d'induction. *G.* Induktionsspule (f); **primary,** *F.* bobine (f) primaire. *G.* primäre Spule (f).

Collar. *F.* rondelle (f). *G.* Scheibe (f). *F.* bague (f). *G.* Ring (m).

Combustion. *F.* combustion (f). *G.* Verbrennung (f); **chamber,** *F.* Culasse (f). *G.* Cylinderboden (m).

Commutator. *F.* commutateur (m) conjoncteur. *G.* Kommutator (m).

Contact, sliding. *F.* contact (m) frotteur. *G.* Schleifkontakt (m); Reibungskontakt (m).

Cooling, air. *F.* refroidissément (m) par air. *G.* Luftkühlung (f); **by water.** *F.* refroidissément (m) par eau. *G.* Wasserkühlung (f).

Coppersmith. *F.* chaudronnier (m). *G.* Kupferschmied (m).

Corners and Curves. *F.* coin (m) de rue; courbe (f). *G.* Ecken (f) und Kurven (f).

Counter-shaft. *F.* arbre (m) de transmission. *G.* Transmissionswelle (f).

Coupling. *F.* accouplement (m). *G.* Kupplung (f); Verbindung (f); **clutch.** *F.* manchon (m) d'embrayage. *G.* Klauenkupplung (f); **hose,** *F.* joint (m) pour manches de pompe. *G.* Schlauchverschraubung (f). *F.* raccord (m). *G.* Schlauchkupplung (f). (*See* INDIA-RUBBER); **universal,** *F.* cardan (m). *G.* Kardanische Gelenk (n).

Cover. *F.* envelopper. *G.* Umhüllen (verb). *F.* chapeau (m). *G.* Deckel (m) (noun); **piston,** *F.* couronne (f) de piston. *G.* Liderungsring (m).

Covering, boiler. *F.* chemise (f). *G.* Kesselverkleidung (f). *F.* garniture (f). *F.* enveloppe (f) d'une chaudière; **pipe,** *F.* enveloppe (f) d'un tuyau. *G.* Rohrbekleidung (f).

Cracked. *F.* Crevé-ée. *G.* geplatzt, geborsten.

Crank. *F.* bras (m). *G.* Arm (m); Kurbel (f).

Cross-head. *F.* coulisseaux (m). *G.* Geradführungsbacken (m). *F.* tête (f) croisée. *G.* Kreuzkopf (m); **block,** *F.* glisseur (m). *G.* Gleitklotz (m).

Crowbar. *F.* levier (m). *G.* Hebeeisen (n).

Current, charging. *F.* courant (m) de charge. *G.* Ladungsstrom (m); **continuous,** *F.* courant (m) continu. *G.* Gleichstrom (m); **direction of the,** *F.* sens (m) du courant. *G.* Richtung (f) des Stromes. *F.* direction (f) de courant. *G.* Stromrichtung (f); **induced,** *F.* induit (m) courant. *G.* induzierte strom (m); **leakage of,** *F.* perte (f) de courant. *G.* Stromverlust (m); Stromstrennung (f).

Cushion. *F.* Coussin. *F.* palier (m). G. Zapfenlager (n).

Cylinder, deposit in the. *F.* crasse (f) dans le cylindre. *G.* Schlacke (f); **high-pressure,** *F.* cylindre (m) à haute pression. *G.* Hochdruckcylinder (m); **jacketed,** *F.* cylindre (m) à chemise. *G.* Cylinder (m); **low-pressure,** *F.* cylindre (m) à basse pression. *G.* Neiderdruckcylinder (m); **top of the,** *F.* culasse (f). *G.* Cylinderboden (m).

D

Density. *F.* densité (f). *G.* Dichtigkeit (f).

Dilute, to. *F.* diluer. *G.* verdünnen.

Dimension, superficial. *F.* dimension (f) superficielle. *G.* Flächenabmessung (f).

Disconnect, to. *F.* déclancher. *G.* losmachen, ausrücken.

Disengage, to. *F.* débrayer, dégager. *G.* ausrücken.

Dishing, of wheels. *F.* carossage (m). *G.* Achsschenkelstrirtz (m).

Dissolve. *F.* dissoudre. *G.* auflösen.

Distribution-shaft. Half-time shaft or cam-shaft. *F.* arbre (m) de distribution. *G.* Verteilungswelle (f).

Door, fire. *F.* porte (f) de fourneau. *G.* Feuerthür (f).

Double-acting. *F.* à double effet. *G.* doppelt-wirkend.

Draught, forced. *F.* tirage (m) forcé. *G.* verstärkte Zug (m).

Drill. *F.* perçer. *G.* bohren. *F.* percoir (m). *G.* Bohrer (m).

Dust. *F.* Poussière (f). *G.* Staub (m).

Dynamo, continuous current. *F.* dynamo (f) à courant continu. *G.* Gleichstromdynamo (f).

E

Ebonite. *F.* caoutchouc (m) durci. *G.* Ebonit (m).

Eccentric Rod. *F.* barre (f) d'excentrique. *G.* Exzentrikstange (f). *F.* tige (f) d'excentrique. *G.* Excenterstange (f). *F.* tirant (m) d'excentrique.

Efficiency, electrical. *F.* rendement (m) électrique. *G.* elektrische, Wirkungsgrad (m); **mechanical,** *F.* rendement (m) industriel. *G.* mechanische Wirkungsgrad (m).

Electric Light Station. *F.* station (f) électrique. *G.* Lichtanlage (f) Elektrizitätswerk (n).

Electromobile. *F.* accumobile (m); automobile électrique. *G.* Akkumobil (n); elektrische Automobil (n).

Engine, to warm the. *F.* rechauffer la machine. *G.* anwärmen.

Estimate. *F.* devis (m). *G.* Anschlag (m).

Evaporation. *F.* évaporation (f). *G.* Verdampfung (f).

Examine, to. *F.* visiter. *G.* untersuchen.

Exhaust. *F.* échappement (m) de la vapeur. *G.* Auslassen (n) Entweichen (n) des Dampfes; **port,** *F.* lumière (f) d' échappement de la vapeur. *G.* Dampfaustritts-öffnung (f) am Cylinder.

Expander, tube. *F.* cylindres (m) pour agrandir les tubes, pour rendre solides les tubes. *G.* Rohrwalzapparat (m).

Expansion. *F.* allongement (m). *G.* Dehnung (f); Expansion (f); **variable,** *F.* detente (f) variable. *G.* veränderliche Expansion (f).

F

Faultfinding. *F.* recherche de defauts. *G.* Fehleruntersuchung (f).

Feed Delivery Pipe. *F.* tuyau (m) de refoulement de la pompe d'alimentation. *G.* Speisepumpendruckrohr (n); **pipe,** *F.* tube (m) alimentaire. *G.* Speiserohr (n); **pump,** *F.* pompe (f) alimentaire. *G.* Speisepumpe (f); **water,** *F.* eau (f) d'alimentation. *G.* Speisewasser (n).

Felt. *F.* feutre (m). *G.* filz (m).

Fiber, vulcanized. *F.* fibre (f) vulcanisè. *G.* Vulkanfiber (f).

File, flat. *F.* lime (f) plate. *G.* Flachfeile (f); **half-round,** *F.* lime (f) demi-ronde. *G.* Halbrundfeile (f); **round,** *F.* lime (f) rounde. *G.* Rundfeile (f); **three-cornered,** *F.* lime (f) triangulaire. *G.* Dreikantfeile (f).

File off, to. *F.* enlever avec la lime. *G.* abfeilen.

Fill, to. *F.* remplir. *G.* füllen.

Fire-box. *F.* boîte (f) à feu. *G.* Feuerbüchse (f). *F.* caisse (f) à feu; foyer (m) d'une chaudière. *G.* Feuerraum (m); **tube,** *F.* tube (m) de chaudière. *G.* Flammrohr (n).

Firing-irons. *F.* râble (m). *G.* Haken (m) Feuerhaken (m).

Fitter. (*See* REPAIRERS.) *F.* mecanicien (m). *G.* Me-

chaniker (m); **engine**, *F.* monteur (m). *G.* Maschinenschlösser (m).

Flange, to. *F.* border. *G.* bordeln.

Flange, wheel. *F.* saillie (f) d'une roue. *G.* Spurkranz (m).

Flaw (in a casting). *F.* chambre (f). *G.* Blase (f).

Flawed. *F.* pailleux, euse. *G.* unganz.

Flexible Coupling. *F.* accouplement (m) flexible. *G.* Universalgelenk (n); biegsame Kupplung (f).

Flexible Shaft. *F.* accouplement (m) flexible; cardan (m). *G.* Kreuzgelenkkupplung (f).

Floát. *F.* flotteur (m) aube (f). *G.* Schwimmvorrichtunge (f) Schanfel (f).

Flue, of steam car. *F.* courant (m) de flamme. *G.* Feverkanal.

Forge, smith's. *F.* feu (m) de forge. *G.* Schmiede (f).

Foundry, brass. *F.* fonderie (f) de bronze. *G.* Messinggiesserei (f); **iron**, *F.* fonderie (f) de fer. *G.* Eisengiesserei (f).

Frame. *F.* bâti (m). *G.* Gestell (n). *F.* bord (m). *G.* Kante (f). *F.* châssis (m). *G.* wagengestell (n).

Friction. *F.* friction (f). *G.* Reibung (f); **loss by**, *F.* perte (f) par friction. *G.* Reibungsverlust (m).

Frost, burst water jacket due to. *F.* cylindre fendu par la gelée. *G.* Wassermantel durch Frost geborsten.

Funnel. *F.* entonnoir (m). *G.* Trichter (m). *Itl.* imbuto (m). *F.* cheminée (f) en tôle (of sheet iron). *G.* Blechkamin (m).

Furnace, boiler. *F.* fourneau (m). *G.* Kesselofen (m); Kesselfeuerung (f).

Fuse, electric. *F.* fusée (f); plomb (m) fusible. *G.* Schmelzsicherung (f); Sicherung (f).

Fuse, to. *F.* fondre. *G.* schmelzen.

G

Galvanize, to. *F.* Fr. zinquer. *G.* verzinken.

Gases, hot. *F.* gaz (m) calorifères; gaz chando. *G.* Heizgase (n).

Gasoline. (*See* PETROL.)

Gauge. *F.* calibre (m). *G.* Schablone (f). *F.* gauge (f). *G.* Aichmafs (n); **glass**, *F.* tube (m) indicateur. *G.* Wasserstandsglas (n); **pressure**, *F.* manomètre (m). *G.* Druckmesser (m); **water**, *F.* échelle (f) d'eau. *G.* Wassermesser (m). *F.* marque (f) d'eau. *G.* Pegel (m). *F.* indicateur (m) de niveau d'eau. *G.* Wasserstandsanzeiger (m); **wire**, *F.* jauge (f) des fils. *G.* Drahtleere (f).

Gauze, wire. *F.* tissu (m) métallique. *F.* toile (f) metalique.

Gear, bevel. *F.* engrenage (m) biais; **differential,** *F.* différentiel (m). *G.* Differentialgetriebe (n).

Gear or Mesh, to. *F.* endenter. *G.* verzahnen. *F.* engrener. *G.* eingreifen.

Glass Paper. *F.* papier (m) verré. *G.* Glaspapier (n).

Gloves. *F.* Gants (m pl). G. Handschuhe (f pl).

Goggles. *F.* Lunettes (f pl). *G.* Staubbrillen.

Governor. *F.* Régulateur (m). *G.* Regulator (m); **shaft,** *F.* arbre (m) du régulateur. *G.* Regulatorspindel (f).

Gradient. *F.* pente (f); rampe (f). *G.* Weigung (f).

Graphite. *F.* plombagine (f). *G.* Graphit (m).

Grate Surface. *F.* surface (f) de la grille. *G.* Rostfläche (f).

Gravity, center of. *F.* centre (m) de gravité. *G.* Schwerpunkt (m).

Grease. *F.* graisse (f). *G.* Fett (n); **axle,** *F.* graisse (f) pour les essieux. *G.* Achsenschmiere (f); **box,** *F.* godet (m) graisseur. *G.* Ölbüchse. (f). *F.* boîte (f) à graisse. *G.* Lagerbüchse (f).

Grease, to. *F.* graisser. *G.* schmieren. (*See* LUBRICATION.)

Grind, to. *F.* frotter; broyer. *G.* reiben. (Cp. "Valves"); **with emery, to,** *F.* polir avec de l'éméri. *G.* nachschleifen.

Groove. *F.* gorge (f). *G.* Rille (f).

Gudgeon. *F.* Pivot (m). *G.* Zapfen (m).

Guide-rod. *F.* guide (m). *G.* Leitstange (f). *F.* tige (f) conductrice. *G.* Führungsstange (f).

H

Hammer. *F.* marteau (m). *G.* Hammer (m); **sledge,** *F.* marteau (m) à devant. *G.* Vorschlaghammer (m); Schmiedehammer (m).

Handle. *F.* Chas (m); manche (m); manchon (m). *F.* poignée (f). *G.* Heft (n); Handhabe (f); Hebel (m) (of a lever); **crank,** *F.* manivelle (f). *G.* Handkurbel (f).

Hanger. *F.* palier (m) suspendu. *G.* Hängelager (n).

Harden, to. *F.* endurcir. *G.* härten. (*See* article on TOOLS.)

Heat, loss of. *F.* déperdition (f) de chaleur. *G.* Wärmeverlust (m). *F.* perte (f) de chaleur.

Heater, feed-water. *F.* tube (m) à réchauffeur. *G.* Vorwärmer (m).

Heating. *F.* réchauffement (m). *G.* Erhitzung (f); **apparatus, steam.** *F.* calorifère (m) à vapeur. *G.* Dampfheizvorrichtung (f); **coil,** *F.* serpentine (m) réchauffeur. *G.* Heizschlange (f).

Hinge. *F.* Charnière (f); gond (m); pivot (m). *G.* Gelenk (n); Thürband (n).

Hood. *F.* capote (f). *G.* Lederdach (m).

GLOSSARY

Horn. *F.* corne (f); Trompette (f).

Horse-power. *F.* cheval - vapeur (m). *G.* Pferdestärke (f); Pferdekraft (f).

I

Ignition, advance. *F.* l'allumage (m), avance à. *G.* Vorzündung (f); **faults, electric,** *F.* défauts de l'allumage électrique; **retard,** *F.* l'allumage (m), retard à. *G.* Nachzündung (f); **rotating magneto-electric,** *F.* magnéto (m) rotatif. *G.* rotierende magnetelektrische Zündaparat (m). **timing,** *F.* allumage réglage (m). Entzundungregulierung (f); to advance – voreilen; to retard – nacheilen.

Improve, to. *F.* retravailler. *G.* verbessern.

Incrustation. *F.* sédiments (m). *G.* Kesselstein (m). *F.* incrustations (f). *G.* Wasserstein (m).

India-rubber. *F.* caoutchouc (m). *G.* Kautschuk (m); Gummi (n); **vulcanized,** *F.* caoutchouc (m) vulcanisé. *G.* vulkanisierter Kautschuk (m); **pipe,** *F.* tuyau (m) en caoutchouc. *G.* Gummirohr (n); Kautschukrohr (n).

Induction, self-. *F.* self-induction (f). *G.* Selbstinduktion (f).

Injector, lubricant. *F.* seringue (f) pour graisser. *G.* Öl-spritze (f).

Insoluble. *F.* insoluble. *G.* unlösbar.

Inspection Hole. *F.* visière (f); trou (m) de visière. *G.* Schauloch (n); **plate,** *F.* visière (f), couvercle de. *G.* Schaulochdeckel (m).

Insulation. *F.* isolation (f). *G.* Isolierung (f). (*See* India-rubber, Ebonite.)

Insulator, porcelain. *F.* isolateur (m) en porcelaine. *G.* Porzellan-Isolator (m).

Insurance. *F.* assurance (f). Life insurance. *F.* assurance sur la vie. Fire insurance. *F.* assurance contre l'incendie. *G.* Versicherung (f).

Iron, cast, *F.* fer (m) coulé; fer fondre. *G.* gusseisen (n); **fine-grained,** *F.* fer (m) aciéreux. *G.* Feinkorneisen (n); **galvanized,** *F.* fer (m) galvanisé. *G.* verzinkte Eisen (n); **malleable,** *F.* fer (m) malléable. *G.* schmiedbare Eisen (n); **plate,** *F.* fer (m) en lames. *G.* Eisenblech (n); **soft,** *F.* fer (m) doux. *G.* weiche Eisen (n); **soldering,** *F.* fer (m) à souder. *G.* Lötkolben (m); **thin sheet,** *F.* fer (m) en feuilles. *G.* schwache Eisenblech (n); **wrought,** *F.* fer (m) battu. *G.* Schmiedeisen (n); **tube,** *F.* tube (m) en fer. *G.* Eisenrohr (n)

J

Jack. *F.* cric (m) à cremaillère. *G.* Aufzugwinde (f); Wagewinde (f).

Joint, ball and socket. *F.* joint (m) spherique. *G.* Krugel.

gelenk (n); **expansion,** *F.* joint (m) glissant. *G.* Expansionerőhren verbindung (f); **flange,** *F.* joint (m) à bride. *G.* Flanschen-verbindung (f); **of pipes, socket,** *F.* joint (m) à manchons. *G.* Muffenverbindung (f); **screw,** *F.* joint (m) à vis. *G.* Schraubenkuppelung (f); **T,** *F.* pièce (f) en T. *G.* T Stück (n); **universal,** *F.* joint (m) brisé. *G.* Universalgelenk (n).

K

Kerosene. (*See* PETROLEUM.)

Key. *F.* cale (f). *G.* Schlussel (n). *F.* clavette (f); **driver,** *F.* chasse-clef (m). *G.* Keiltreiber (m).

Knocking. *F.* tapage (f).

L

Lamp. *F.* Lampe (f). *G.* Lampe (f); **gas,** *F.* lampe (f) à gaz; à acetylène. *G.* Gaslampe (f) **incandescent,** *F.* lampe (f) à incandescence. *G.* Inkandescenzlampe (f).

Lead, peroxide of. *F.* plomb (m) peroxide (m) de. *G.* Bleisuperoxyd (n); **red,** *F.* plomb (m) oxydé rouge. *G.* Mennige (f); **sheet,** *F.* feuille (f) de plomb. *G.* Walzblei (n). *F.* lame (f) de plomb; plomb (m) laminé. *G.* Bleiblech (n); **tube,** *F.* tuyau (m) de plomb. *G.* Bleirohr (n); **white,** *F.* plomb (m) blanc. *G.* Bleiweifs (n).

Leakage, of water or petrol. *F.* perte d'eau; perte d'essence. *G.* Wasserleckwerden (n).

Leak, to. *F.* fuir; faire eau. *G.* Leckwerden; **inward,** *F.* prendre eau. *G.* leck werden.

Leather, to cover with. *F* garnir de cuir (un piston). *G.* lidern; **collar,** *F.* manchette (f) en cuir. *G.* Ledermanschette (f).

Lend. *F.* Preter. *G.* leihen, verleihen.

Letters on Coils. *F.* Lettres sur les bobbines. *G.* Buchstaben (m pl) auf den Spalen (f pl).

Level Crossing. *F.* passage (m) à niveau droit. *G.* Niveauübergang (m); **water,** *F.* niveau (m) de l'eau. *G.* Wasserspiegel (m).

Lever, brake. *F.* levier (m) de l'arbre du frein. *G.* Bremshebel (m); **pump,** *F.* levier (m) de pompe. *G.* Pumpedhebel (m); **reversing,** *F.* levier (m) de renversement. *G.* Umsteurungshabel (m); **starting,** *F.* levier (m) a main; de mise en marche. *G.* Handhelbel (m); **to throw in or out** (clutch or gear). *F.* levier (m) d'embrayage et de disembrayage. *G.* Ein-und Ausruckhebel (m).

License, for cars, etc. *F.* Permit (m). *G.* Erlaubniss (f).

Lifter. *F.* toc (m). *G.* Mitnehmer (m).

Link, coupling. *F.* joint (m) d'accouplement. *G.* Kuppelgelenk (n).

Lock-nut, Set-screw. *F.* contreécrou (m). *G.* Contremutter (f).

Lubrication, splash. *F.* graissage (m) par barbotage (m).

Lubricator. *F.* appariel (m) graisseur—de graissage. *G.* S c h m i e r v o r r i chtung (f); Schmierer (m); **mechanically operated,** *F.* lubrifacteur (m) méchanique. *G.* Selbstöler. *F.* lubrificateur (m). *G.* selbstthätige Schmierapparat (m); **sight feed.** *F.* graisseur (m) à goutte visible. *G.* Tropföler (m).

Lug. *F.* anneau (m) œil (m). *G.* Ose (f).

M

Machine Oil. *F.* graisse (f) à machine. *G.* Schmieröl (n). (*See* LUBRICATION.)

Machine, pieces of, *F.* pièces (f) de machine. *G.* Maschinenteile (m); **starting of a,** *F.* mise (f) en mouvement. *G.* Ingangsetzung (f); Anlassen (n); **work,** *F.* ouvrage (m) à la mécanique. *G.* Maschinenarbeit (f).

Magnetic Field. *F.* champ (m) magnétique. *G.* magnetische Feld (n).

Maintenance. *F.* entretien (m). *G.* Unterhaltung (f).

Mallet. *F.* marteau (m) en bois. *G.* Holzhammer (m).

Mandril. *F.* broche (f). *G.* Dorn (m).

Measure. *F.* mesure (f). *G.* Mass (n).

Mechanism. *F.* dispositif (m). *G.* Vorrichtung (f). *F.* appariel (m).

Metal, white. *F.* métal (m) blanc. *G.* Weissmetall (n).

Misfire. *F.* raté (m). *G.* Versager (f).

Mixture, explosive. *F.* mélange (m) explosif. *G.* Explosionsgemisch (n); **too rich,** *F.* gas (m) riche. *G.* stark angereicherte Gas (n).

Motion, center of. *F.* point (m) d'appui. *G.* Stützpunkt (m); **eccentric,** *F.* mouvement (m) excentrique. *G.* excentrische Bewegung (f); **forward,** *F.* mouvement (m) d'avancement. *G.* Vorwärtsbewegung (f). *F.* marche (f) avant. *G.* Vorwärtsgang (f); **link,** *F.* distribution (f) à coulisse. *G.* Coulissensteuerung (f); **parallel,** *F.* mouvement (m) parallèle. *G.* Parallelbewegung (f); **reciprocating,** *F.* mouvement (m) alternatif. *G.* Vor- und Rückgang (m); **reverse,** *F.* mouvement (m) en arrière. *G.* Rückwärtsbewegung (f). *F.* marche (f) arrière. *G.* Rückwartsgang (m); **rotatory,** *F.* mouvement (m) rotatoire. *G.* drehende Bewegung (f); **vertical,** *F.* mouvement (m) vertical. *G.* Freifallbewegung (f); Vertikalebewegung (f).

Motor, crank for starting the. *F.* manivelle (f) de lancement. *G.* Anlasskurbel (f); **explosion,** *F.* moteur (m) à ex-

plosion. *G.* Explosionsmotor (m); **four-cycle,** *F.* moteur à quatre temps. *G.* Viertaktmotor (m); **petrol,** *F.* moteur à petrole. *G.* Benzinmotor (m); **running of the,** *F.* marche (f) du moteur. *G.* Gang (m) des Motors; **steam,** *F.* moteur (m) à vapeur. *G.* Dampfmaschine (f). (*See* STEAM); **two-cycle,** *F.* moteur à deux temps. *G.* Zweitaktmotor (m).

Motor-car, petrol. *F.* automobile (m) à pétrole. *G.* Benzinmotorwagen (m); **steam,** *F.* automobile (m) à vapeur. *G.* Dampfmotorwagen (m).

Motor-shaft. *F.* axe (m) moteur. *G.* Treibachse (f), Treibwelle (f).

Motorist. *F.* chauffeur (m). *G.* Führer (m) eines Automobils.

Movable. *F.* amovible. *G.* auswechselbar.

Mud-hole. *F.* orifice (m) de nettoyage. *G.* Schlammloch (n).

Muffler. *F.* étouffoir (m); pot d'échappement. *G.* Auspufftopf (m); muffler (m).

N

Nail. *F.* broche (f). *G.* Nagel (m) (finger-nail - ougle) (m).

Naphtha. *F.* bitume (m) liquide. *G.* Naphta (f).

Needle. *F.* épine (f). *G.* Nadel (f).

Negative Pole. *F.* pôle (m) negatif. *G.* negative Pol (m).

Nickel. *F.* nickeler. *G.* vernickeln.

Nozzle. *F.* bouche (f) de la buse. *G.* Düse (f).

Nut. *F.* écrou (m). *G.* Mutter (f); **and bolt,** *F.* boulon (m) à écrou. *G.* Schraubenbolzen (m).

O

Oblique. *F.* oblique. *G.* schief.

Oil, boiled linseed. *F.* huile (f) de lin cuite. *G.* gekochte Leinöl (n); **castor,** *F.* huile (f) de ricin. *G.* Ricinusöl (n); **glass cup,** *F.* vase (m) en verre. *G.* Nadelschmierglas (n); **lamp,** *F.* huile (f) à brûler. *G.* Brennöl (n); **lubricating,** *F.* graisse (f) minérale. *G.* Mineralschmieröl (n). (*See* LUBFICATION); **mineral,** *F.* huile (f) minérale. *G.* Mineralöl (n).

Oil Box. *F.* boîte (f) à huile. *G.* Achsbüchse (f), Oelbüchse (f); **can,** *F.* cannette (f) à huile. *G.* Schmierkanne (f); **cup,** *F.* vase (m) de graissage. *G.* Schmiervase (f); **inlet,** *F.* trou (m) de graissage. *G.* Schmieröffnung (f).

Out of Gear. *F.* débrayé, ée. *G.* ausgerückt.

Outflow. *F.* écoulement (m). *G.* Abfluss (m).

Outlet. *F.* ouverture (f); épanchoir (m). *G.* Offnung (f); Abfluss (m); **water,** *F.* prise (f) d'eau. *G.* Wasseraustritt (m).

Overcharge. *F.* surcharge (f). *G.* Ueberdruck (m); Ueberladung (f).

Overheating. *F.* le moteur chauffe = the engine heats.

Oxide. *F.* oxyde (m). *G.* Oxyd (n).

P

Pack, to. *F.* emballer. *G.* verpacken.

Packing, asbestos. *F.* toile (f) d'asbeste. *G.* Asbestgewebe (n). *F.* garniture (f) d'asbeste; étoupe (f) d'asbeste. *G.* Asbestpackung (f); **hemp,** *F.* garniture (f) de chauvre. *G.* Hanfliderung (f), Hanfdichtung (f); **india-rubber,** *F.* etoupage (m) de caoutchouc garniture (f) de caoutchouc. *G.* Kautschukliderung (f) Kautschukdichtung (f); **metallic,** *F.* garniture (f) métallique. *G.* Metalliderung (f).

Packing Cloth. *F.* toile (f) d'emballage. *G.* Packleinwand (f).

Paint. *F.* Peinture. *G.* Anstrich (m).

Paraffin. *F.* paraffin (f). *G.* Paraffin (n).

Paralleling (accumulators or cells). *F.* accomplement (m) en quantité des piles. *G.* Parallelschaltung (f).

Pawl. *F.* taquet (m) d'arrêt. *G.* Sperrklinke (f).

Pedal, brake. *F.* pédale de frein. *G.* Pedalbremse (f); **clutch,** *F.* pédale de l'embrayage. *G.* Pedal.

Perforate, to. *F.* forer. *G.* bohren. *F.* percer. *G.* lochen.

Perforated. *F.* perforé. *G.* perforiert.

Perpendicular. *F.* plomb, à. *G.* vertikal.

Petrol. *F.* pétrole (m); essence (f). *G.* Erdöl (n); Petrol.

Petroleum. *F.* oléonaphte (m). *G.* Petroleum (n).

Pin. *F.* goujon (m). *G.* Kontaktsift (m). *F.* pivot (m). *G.* Führungsstift (m); **crank,** *F.* prisonnier (m). *G.* Kurbelzapfen (m); **cross-head,** *F.* pivot (m) du patin. *G.* Glitscherzapfen (m); **detent,** *F.* pivot (m) d'arrêt. *G.* Anstosszapfen (m); **gudgeon,** *F.* boulon (m). *G.* Bolzen (m); **joint,** *F.* goujon (m) de charnière. *G.* Gewindestift (m).

Pincers. *F.* ténaille (f). *G.* Zange (f). *F.* pince (f) coupante. *G.* Beisszange (f). (*See* Tools.)

Pinion. *F.* pignon (m). *G.* Getriebe (n); **bevel,** *F.* pignon (m) d'angle. *G.* konische Getriebe (n); **spur,** *F.* pignon (m) droit. *G.* Stirngetrieb (n).

Pipe, cast-iron. *F.* tuyau (m) en fonte. *G.* gufseiserne Rohr (n); **circulating,** *F.* tuyau (m) de circulation; tuyau d'eau. *G.* Cirkulationsrohr (n); **inlet,** *F.* tuyau (m) d'induction; d'admission; d'introduction; d'alimentation. *G.* Eintrittsrohr (n); Speiserohr (n); **steam,** *F.* conduit (m) de vapeur. *G.* Dampfrohr (n).

Piston, clearance of a. *F.* vent (m) d'un piston. *G.* Spielraum (m) eines Kolben; **low pressure,** *F.* piston (m) à basse pression. *G.* Niederdruckkolben (m); **packing of the,** *F.* garniture (f) du piston. *G.* Kolbenliderung (f); **play of the,** *F.* jeu (m) du piston. *G.* Kolbenspiel (n); **speed of the,** *F.* vitesse (f) du piston. *G.* Kolbengeschwindigkeit (f); **steam,** *F.* piston (m) à vapeur. *G.* Dampfkolben (m); **stroke of the,** *F.* tour (m) du piston. *G.* Kolbenhub (n); **rings,** *F.* segments, cercles (m pl) de contact du piston. *G.* Kolbenringen (m pl) Kolbenring (m); **rod,** *F.* tige (f) de piston. *G.* Kalbenstange (f); **rod, bush of a,** *F.* douille (f) de la tige de piston. *G.* Hülse (f) der Kolbenstangen-führung; **rod, cross-head of a,** *F.* crosse (f) de la tige du piston Té (m) du piston. *G.* Kreuzkopf (m); **rod, lengthened,** *F.* piston (m) allongé. *G.* verlängerte Kolbenstange (f).

Pit. *F.* fosse (f). *G.* Grube (f).

Pivot. *F.* pivot (m). *G.* Drehpunkt (m); Stift (m). *F.* centre (m) de mouvement. *G.* Gewindezapfen (m); Mittelpunkt (m).

Plate, division. *F.* plate-forme (f) à diviser. *G.* Teilscheibe (f); **metal,** *F.* plaque (f) en métal. *G.* Metallplatte (f).

Platinum. *F.* platine (m). *G.* Platin (n).

Play, to have not sufficient. *F.* s'entreserrer. *G.* **sich klemmen.**

Pliers, flat. *F.* pince (f) plate. *G.* Klemmbacke (f).

Plug. *F.* bouton (m). *G.* Stöpsel (m); **fusible,** *F.* bouchon (m) fusible. *G.* schmelzbarer Stöpsel (m); **sparking,** *F.* bougie (f). *G.* Zünder (n).

Plumb-line. *F.* plomb (m). *G.* Gleischnur (f).

Point. *F.* pointeau (m). *G.* Spitze (f).

Polish, to. *F.* polir; brunir. *G.* polieren.

Porous. *F.* poreux, se. *G.* porös.

Positive Pole. *F.* pôle (m) positive. *G.* positiv Pol (m).

Power, candle. *F.* puissance (f) en bougies. *G.* Kerzenstärke (f); **loss of,** *F.* perte (f) de force. *G.* Kraftverlust (m); **motive,** *F.* force (f) d'impulsion. *G.* Triebkraft (f) force (f) impulsive; **steam,** *F.* force (f) de vapeur. *G.* Dampfbetrieb (m).

Pressure. *F.* poussée (m). *G.* Druck (m); **high,** *F.* pression (f) haute. *G.* Hochdruck (m). *F.* haute-pression (f). *G.* Hochdruck (m); **loss of,** *F.* perte (f) de charge. *G.* Druckhöheverlus (m); **low,** *F.* pression (f) basse. *G.* Niederdruck (m); **of steam,** *F.* tension (f) de la vapeur. *G.* Dampfspannung (f); **terminal,** *F.* pression (f) finale. *G.* Endspannung (f); **test,** *F.* épreuve (f) de pression. *G.* Druckprobe (f).

Prices of Cars. *F.* Prix. *G.* Kosten.

Pulley. *F.* tambour (m). *G.* Riemscheibe (f). *F.* poulie (f). *G.* Rolle (f).

Pumice stone. *F.* lave (f) pumicée pierre ponces (f). *G.* Bimsstein (m).

Pump, centrifugal. *F.* pompe (f) centrifuge. *G.* Zemtrifugalpumpe (f); **double-acting,** *F.* pompe (f) à double effet. *G.* doppelt-wirkende Pumpe (f); **force,** *F.* pompe (f) foulante. *G.* Druckpumpe (f); **hand,** *F.* pompe (f) à bras. *G.* Handpumpe (f); **oil,** *F.* pompe (f) à huile. *G.* Ölpumpe (f); **piston,** *F.* pompe (f) à piston. *G.* Kolbenpumpe (f); **plunger,** *F.* pompe (f) à piston plongeur. *G.* Plungerkolbenpumpe (f); **rotary,** *F.* pompe (f) rotatif. *G.* Rotationspumpe (f). Ltd; **steam feed,** *F.* pompe (f) d'alimentation à vapeur. *G.* Dampfspeisepumpe (f); **suction,** *F.* pompe (f) aspirante *G.* Saugpumpe (f); **(water circulation),** *F.* pompe à eau. *G.* Pumpe (f); **rod,** *F.* tige (f) de pompe. *G.* Pumpenstange (f).

Punch. *F.* poinçon (m). *G.* Stanze (f). *F.* estampe (f). *G.* Stanze (f); **center,** *F.* pointe (f). *G.* Körner (m).

Punch, to. *F.* poinçonner; découper. *G.* stanzen; durchschlagen.

R

Racket. *F.* cliquet (m) du percoir à rochet. *G.* Bohrknarre (f).

Radiator. *F.* radiateur (m). *G.* Kühlschlange (f).

Ratchet. *F.* rochet (m). *G.* Ratsche (f).

Reflector. *F.* réflecteur (m). *G.* Reflektor (m).

Regulation, automatic. *F.* réglage (m) automatique. *G.* automatische Regelung (f). (*See* GOVERNOR); **by hand,** *F.* réglage (m) à main. *G.* Handregulierung (f). (*See* THROTTLE.)

Regulator, pressure. *F.* régulateur (m) à pression. *G.* Druckregulator (m).

Repair. (*See* BREAKDOWN, ETC.). *F.* réparation (f). *G.* Reparatur (f); Instandsetzung (f); **cost of,** *F.* frais (m) de réparation. *G.* Reparaturkosten (f).

Repairers and other tradesmen: armorer, steel worker. *F.* armurier (m). *G.* Waffenschmied (m); **brazier, brass worker,** *F.* chaudronnier (m). *G.* Kupferschmied (m); **carpenter,** *F.* charpentier (m). *G.* Zimmermann (m); **coachmaker,** *F.* carrossier (m). *G.* Wagenbauer (m); **cooper,** *F.* tonnelier (m). *G.* Küfer (m); **druggist,** *F.* droguiste (m). *G.* Materialist (m); **gunsmith,** *F.* arquebusier (m). *G.* Buchsenschmied (m); **harnessmaker,** *F.* bourrelier (m). *G.*

Riemer (m); **ironmonger,** *F.* ferronnier (m). *G.* Eisenhändler (m); **joiner,** *F.* menuisier (m). *G.* Tischler (m); **locksmith,** *F.* serrurier (m). *G.* Schlosser (m); **saddler,** *F.* sellier (m). *G.* Sattler (m); **tinman,** *F.* ferblantier (m). *G.* Blechschläger (m); **turner,** *F.* tourneur (m). *G.* Drechsler (m); **upholsterer,** *F.* tapissier (m). *G.* Tapezierer (m); **wheelwright,** *F.* charron (m). *G.* Wagner (m).

Reservoir. *F.* bassin (m). *G.* Behälter (m). *F.* reservoir (m). *G.* Wasserbehälter (m).

Resin. *F.* résine (f). *G.* Harz (n).

Resistance. *F.* résistance (f). *G.* Widerstand (m); **compression,** *F.* résistance (f) de compression. *G.* Druckfestigkeit (f); **electric,** *F.* résistance (f) électrique. *G.* elektrischer Widerstand (m).

Reversing Shaft. *F.* arbe (m) de changement de marche. *G.* Steuerwelle (f).

Revolution. *F.* révolution (f). *G.* Umlauf (m); **speed of,** *F.* vitesse (f) de rotation. *G.* Umdrehungsgeschwindigkeit (f).

Rim. *F.* jante (f) anneau (m) d'une roue. *G.* Felge (f); Radkranz (m).

Ring, packing. *F.* couronne (f) de l'étoupage. *G.* Tiderungsring (m).

Rivet Head. *F.* tête (f) d'un rivet. *G.* Nietkopf (m).

Roller. *F.* roulette (f). *G.* Rolle (f). *F.* galet (m) d'affût. *G.* Spannrolle (f). *F.* poulie (f) conductrice. *G.* Führungsrolle (f).

Rope, iron wire. *F.* câble (m) en fil de fer. *G.* Eisendrahtseil (n); **tow,** *F.* câble (m) de remorque. *G.* Bugsirtau (n); Schlepptau (n); **wire,** *F.* corde (f) en fil de fer. *G.* Drahtseil (n).

Rotate, to. *F.* se tourner. *G.* rotieren; umdrehen.

Rotation, direction of. *F.* direction (f) de rotation. *G.* Drehrichtung (f). *F.* sens (m) de rotation. *G.* Drehungsrichtung (f).

Rubber Solution. *F.* Dissolution (f). *G.* Losung (f).

Rubbing Surface. *F.* surface (f) de frottement. *G.* Reibungsfläche (f).

Rule of the Road. *F.* règle, loi (f).

Rusty. *F.* rouillé, e. *G.* rostig.

S

Sand. *F.* sable (m). *G.* Sand (m).

Saw. *F.* scie (f). *G.* Säge (f); **blade,** *F.* lame (f) de scie. *G.* Sägeblatt (n); **metal,** *F.* scie (f) à métaux. *G.* Eisensäge (f).

Scale. *F.* dépôts (m) dans les chaudières à vapeur. *G.* Kesselstein (m).

Screw, adjusting. *F.* vis (f) de rappel. *G.* Stellschraube (f). *F.* vis (f) régulatrice. *G.* Adjustierschraube (f); **binding,** *F.* serre-fil (m). *G.* Klemm-

schraube (f). *F.* vis (f) d'arrêt; **counter-sunk,** *F.* vis (f) noyée. *G.* versenkte Schraube (f); **double-threaded,** *F.* vis (f) à double filet. *G.* Doppelschraube (f); **fastening,** *F.* vis (f) à fermer. *G.* Heftschraube (f); **fixing,** *F.* vis (f) de fixation. *G.* Befestigungsschraube (f); **left-hand,** *F.* vis (f) filetée à gauche. *G.* Linksgewinde (n); **pitch of a,** *F.* pas (m) d'une vis. *F.* hauteur (f) du pas d'une vis. *G.* Gewindesteigung (f); **right-hand,** *F.* vis (f) filetée à droite. *G.* rechtsgängige Schraube (f); **round-head,** *F.* vis (f) à tête ronde. *G.* Rundkopfschraube (f); **sunk,** *F.* vis (f) perdue. *G.* versenkte Schraube (f); **terminal,** *F.* vis (f) de pression. *G.* Klemmschraube (f); **thumb,** *F.* vis (f) à oreilles. *G.* Flügelschraube (f); **union,** *F.* raccrod (m) à vis. *G.* Schraubenverbindung (f).

Screw, to. *F.* tarauder. *G.* Gewinde schneiden; to (i. e., to tighten up by means of screws). *F.* serrer à vis. *G.* *G.* anschrauben; to **fasten with a,** *F.* visser. *G.* schrauben.

Screw-driver. *F.* tournevis (m). *G.* Schraubenzieher (m); **head,** *F.* tête (d) de vis. *G.* Schraubenkopf (m); **plate,** *F.* filiére (f) à vis. *G.* Schraubenschneideisen (n); **wrench,** *F.* clef (f) à écrous. *G.* Schraubenschlüssel (m).

Screwed. *F.* attaché à vis. *G.* angeschraubt.

Sediment. *F.* dépôt (m) des matières liquides; sédiment (m). *G.* Bodensatz (m).

Segment. *F.* segment (m). *G.* Segment (n).

Self-firing. *F.* allumage spontanée. *G.* Selbstentzündung.

Sheet. *F.* plaque (f). *G.* Tafel (f); **copper,** *F.* plaques (f) de cuivre. *G.* Kupferblech (n); **india-rubber,** *F.* feuille (f) de caoutchouc. *G.* Kautschukplatte (f).

Shellac. *F.* laque (f) en écailles. *G.* Schellack (m).

Shop, repair. *F.* atelier (m) de réparation. *G.* Reparaturwerkstatt (f).

Side-slip. *F.* dérapage. *G.* Schleudern (n).

Silencer By-pass. *F.* échappement facultatif à air libre; **explosions,** *F.* pot d'échappement, explosions dans le.

Silver, German. *F.* maillechort (m). *G.* Neusilber (n).

Single Acting. *F.* effet (m) à simple. *G.* einfachwirkend.

Siphon. *F.* siphon (m). *G.* Heber (m).

Sleeve, sliding. *F.* fourreau (m). *G.* Gleitmuffe (f).

Slide Valve, inside lap of the. *F.* recouvrement (m) intérieure. *G.* innere Schieberüberdeckung (f); **outside lap of the,** *F.* recouvrement (m) exterieur. *G.* äufsere Schieberüberdeckung (f); **rod,** *F.* armature (f) du tiroir. *G.* Schiebergestänge (n).

Slide Valves, stroke of the. *F.* course (f) du tiroir. *G.* Schieberweg (m); **to adjust the,** *F.* règler (m) les tiroirs. *G.* Schieber (m) berichtigen.

Sliding Block. *F.* coulisseau (m). *G.* Gleitbacken (m).

Smith's Work. *F.* ouvrage (m) de forge. *G.* Schmiedearbeit (f).

Smoke. *F.* fumée (f). *G.* Rauch (m).

Smooth, to. *F.* doucir. *G.* schlichten.

Socket-piece. *F.* tuyau (m) de rallonge.

Solder. *F.* soudure (f). *G.* Lot (n); **hard,** *F.* soudure (f) forte. *G.* Schlagot (n).

Solder, to. *F.* encoller. *G.* löten.

Soldering Iron. *F.* soudoir (m). *G.* Lötkolben (m).

Soot. *F.* suie (f). *G.* Russ (m).

Sound, to. *F.* tinter (v). *G.* ertönen.

Spare Pieces. *F.* pièces (f) de réserve. *G.* Reservestücke (n).

Spark. *F.* étincelle (f). *G.* Funken (m); **break,** *F.* étincelle (f) de rupture. *G.* Unterbrechungsfunken (m); **plug,** *F.* Bougie d'allumage. *G.* Zünder (m).

Speed. *F.* marche (f). *G.* Geschwindigkeit (f). *F.* vitesse (f); **gear,** *F.* changement (m) de vitesse; **proper,** *F.* vitesse (f) normale. *G.* Normalgeschwindigkeit (f).

Spindle. *F.* poilier (m). *G.* Spindel (f). *F.* arbre (m).

Spiral. *F.* hélice, en. *G.* schraubenförmig in Spiralen.

Splash-board. *F.* aile (f). *G.* Kotflügel (m). *F.* garde-crotte (m). *G.* Spitzrahmen (m).

Spoke. *F.* rais (m) d'une roue. *G.* Speiche (f).

Spring. *F.* ressort (m). *G.* Feder (f); **helical,** *F.* ressort (m) spiral. *G.* Spiralfeder (f); **of inlet valve,** *F.* ressort (m) de la soupape d'admission. *G.* Ventilfeder (f); **spiral,** *F.* ressort (m) à boudin. *G.* Spiralfeder (f); **steel,** *F.* ressort (m) d'acier. *G.* Stahlfeder (f); **to compress,** *F.* ressort, serrer un. *G.* eine Feder zusammen pressen; **to expand a,** *F.* ressort (m) détendre un. *G.* eine Feder strecken.

Square. *F.* quadrangulaire. *G.* viereckig.

Square Thread. *F.* filet (m) retangilaire. *G.* flachgängige Gewinde (n).

Starting. *F.* mise (f) en marche; **difficulty,** *F.* difficulté (f) de mise en marche.

Stay, boiler. *F.* tirant (m) d'une chaudière. *G.* Kesselbolzen (m).

Steam. *F.* vapeur (f). *G.* Dampf (m); **exhaust,** *F.* vapeur (f) épulsée. *G.* Abdampf (m); **high pressure,** *F.* vapeur (f) à pression. *G.* Hockruckdampf (m); **live,** *F.* vapeur (f) sous pression. *G.* gespannte

Dampf (m); **low pressure,** *F.* vapeur (f) à basse pression. *G.* Niederdruckdampf (m). (*See* PRESSURE OF STEAM); **saturated,** *F.* vapeur (f) saturée. *G.* gesättigte Dampf (m); **superheated,** *F.* vapeur (f) surchauffée. *G.* überhitze Dampf (m). *F.* vapeur (f) désaturée. *G.* ungesättigte Dampf (m); **to cut off the,** *F.* couper la vapeur. *G.* den Dampf absperren.

Steam Pipe, main. *F.* tuyauterie (f) de vapeur d'admission. *G.* Frischdampfleitung (f); **port,** *F.* lumières (f) d'entrée et de sortie. *G.* Dampfeintrittskanal (m); (exhaust - port = Dampfaustrittskanal (m); **space,** *F.* chambre (f). *G.* Dampfraum (m); **tight,** *F.* étanche de vapeur. *G.* dampfdicht. *F.* imperméable à la vapeur. *G.* dampfdicht.

Steel. *F.* acier (m). *G.* Stahl (m); **hardened,** *F.* acier (m) trempé. *G.* gehärteter Stahl (m); **sheet,** *F.* tôle (f) d'acier. *G.* Stahlblech (n); **tempering of the,** *F.* trempe (f) de l'acier. *G.* Härten (n) des Stahles; **tube,** *F.* tube (m) en acier. *G.* Stahlrohr (n).

Steering-bar. *F.* Guidon (m). *G.* Lenkstange (f).

Steering, non-reversible. *F.* direction (f) irréversible. *G.* unumzukehrene Lenkung (f).

Step. *F.* bourdonnière (f). *G.* Fusslager (n).

Stiffen, to. *F.* renforcer. *G.* versteifen.

Straighten, to. *F.* dresser. *G.* gerade machen.

Strainer. *F.* crépine (f). *G.* Saugkorb (m).

Strengthening. *F.* renforcement (m). *G.* Verstärkung (f).

Stroke. *F.* levée (f). *G.* Hub (m).

Stud. *F.* boulon.

Stuffing-box. *F.* presse-étoupe (f); couvre-étoupe (m). *G.* Stopfbüchsendeckel (m). *F.* boîte (f) étouffante. *G.* Stopfbüchse (f); **gland of a,** *F.* presse-étoupe (f). *G.* Stopfbüchsendeckel (m). *F.* chapeau (m) d'une boîte à étoupes. *G.* Stopfbüchsendeckel (m); **packing of the,** *F.* garniture (f) de la presse-étoupe. *G.* Stopfbüchsenverpackung (f); **piston-rod,** *F.* presse-étoupe (f) de la tige du piston. *G.* Kolben - stangenstopfbüchse (f).

Suction. *F.* aspiration (f). *G.* Saugen (n); **pipe,** *F.* tuyau (m) aspirant. *G.* Saugrohr (n).

Sulphuric Acid. *F.* acide (m) sulfurique. *G.* Schwefelsäure (f).

Superheat. *F.* surchauffer (m). *G.* überhitzen.

Supply. *F.* livraison (f). *G.* Lieferung (f); **pipe,** *F.* tuyau (m) d'arrivée. *G.* Wasserzuflussrohr (n).

T

Tackle, or block. *F.* moufle (f). *G.* Flasche (f).

Tangent. *F.* tengente (f). *G.* Tangente (f).

Tank, oil. *F.* réservoir (m) à huile. *G.* Ölbehälter (m); **water,** *F.* bâch (f) d'eau. *G.* Wasserreservoir (n). *F.* caisse (f) à eau.

Tanks. *F.* reservoirs (m pl). *G.* Behälter (m).

Tap, regulating. *F.* rebinet (m) modérateur. *G.* Abstellhahn (m).

Taper (adjective). *F.* pointu, ue. *G.* spitz.

Tappet. *F.* buttoir (m). *G.* Mitnehmer (m). *F.* came (f) de détente. *G.* Knagge (f). *F.* taquet (m) de deténte. *G.* Daumen (m).

Technical. *F.* technique. *G.* technisch.

Teeth in a Wheel, to put new. *F.* pourvoir un rouet de dents. *G.* ein Rad verkämmen.

Tempered. *F.* trempé. *G.* temperiert; gehärtet.

Templet. *F.* garbarit (m). *G.* Schablone (f).

Tension. *F.* tension (f). *G.* Spannung (f).

Terminal. *F.* serre-lame (m). *G.* Drahthalter (m); Verbindung (f).

Terminals. *F.* vis (f) de pression. *G.* Stellschraube (m); Klemmen (f pl).

Thread. *F.* filet (m). *G.* Gewinde (n). *F.* pas (m). *G.* Gang (m); **double,** *F.* double pas (m) d'une vis. *G.* doppelte Gewinde (n).

Throttle. *F.* réglage (m) à main. *G.* Drosselklappenregulierung (f).

Throttle, to. *F.* reserrer la vapeur; serrer. *G.* drosseln. *F.* modérer la vapeur; étrangler.

Throw. *F.* coup (m). *G.* Hub (m).

Thumbscrew. *F.* écrou (m) ailé. *G.* Flugelmutter (f).

Tie Rod. *F.* tirant (m). *G.* Zugstange (f).

Tight, to make. *F.* étanche rendre. *G.* dichten.

Tin-work. *F.* ouvrage (m) en fer blanc. *G.* Weissblecharbeit (f).

Tire. *F.* bandage (m). *G.* Radreifen (m). *F.* rond (m) de roue. *G.* Radkranz (m).

Tire on a Wheel, to put the. *F.* ferrer une roue. *G.* ein Rad beschlagen.

Tires, pneumatic. *F.* bandage (m); pneumatique (f). *G.* Reifen (m); Radreifen (m).

Tool. *F.* outil (m). *G.* Werkzeug (n). *F.* outillage (m). *G.* Handwerkszeug (n); **box,** *F.* bôite (f) d'outils. *G.* Werkzeugkasten (m).

Tooth. *F.* dent (f). *G.* Kammzahn (m).

Toothed Wheel, pitch of a, *F.* pas (m) de l'engrenage. *G.* Schrift (f) eines ahnrads.

Traction. *F.* attelage (m). *G.* Zug (m); **resistance to,** *F.* rapport (m) de traction. *G.* Zugwiderstand (m).

Transmission. *F.* transmission (f). *G.* Transmission (f).

Transport, charges of. *F.* frais (m) de port. *G.* Transportkosten (f).

Trembler. *F.* ressort interrupteur (m). *G.* Selbstunterbrecher (m). *F.* trembleur (m). *G.* Neef'sche Hammer (m).

Truck. *F.* fardier (m). *G.* Güterwagen (m).

Tube. *F.* tube (m); tuyau (m); manche (f). *G.* Schlauch (m). *F.* conduit (m); tube (m). *G.* Rohr (n); **bent,** *F.* tuyau (m) coudé. *G.* Knierohr (n); **cold-drawn,** *F.* tuyau (m) étiré à froid. *G.* Kaltgezogene Rohr (n); **glass,** *F.* tuyau (m) de verre. *G.* Glasröhre (f); **hot-drawn,** *F.* tuyau (m) tirè à chaud. *G.* Warn gezogene Rohr (n).

Tubular. *F.* forme de tuyau; tubulaire. *G.* röhrenförmig.

Turntable. *F.* pont (m) tournant. *G.* Drehscheibe (f). *F.* plaque (f) tournante.

U

Unbolt. *F.* débarrer. *G.* aufriegeln.

V

Valve, admission. *F.* soupape (f) d'admission. *G.* Drosselventil (n); **annular,** *F.* soupape (f) annulaire. *G.* Ringventil (n); **ball,** *F.* soupape (f) à boulet. *G.* Kugelabsperrventil (n); **blow off,** *F.* soupape (f) de purge. *G.* Ausblaseventil (n); **clack,** *F.* soupape (f) à clapet. *G.* Klappe (f); **conical,** *F.* soupape (f) conique. *G.* Kegelventil (n); **delivery,** *F.* clapet; (m) de refoulement. *G.* Druckventil (n); **exhaust,** *F.* soupape (f) d'échappement; d'évacuation. *G.* Auspuffventil (n). *G.* Abblaseventil (n). *F.* tiroir (m) d'évacuation. *G.* Auslassschieber (m); **feed,** *F.* soupape (f) d'alimentation. *G.* Speiseventil (n); **india-rubber,** *F.* soupape (f) en caoutchouc. *G.* Kautschukventil (n); Guinmiventil (n); **mechanically operated,** *F.* soupape commandée. *G.* Mechanischgetriebene Ventil (n); **piston,** *F.* soupape (f) du piston. *G.* Kolbenventil (n). *F.* tiroir (m) rond. *G.* Rundschieber (m); **relief,** *F.* clapet (m) de retenue. *G.* Rückschlagklappe (f). *F.* soupape (f) à air. *G.* Luftventil (n). *F.* soupape (f) de retenue. *G.* Rückschlagventil (n); **safety,** *F.* soupape (f) de süreté. *G.* Sicherheitsklappe (f); **sliding,** *F.* tiroir (m) plan. *G.* Flachschieber (m); **spare,** *F.* soupape (f) de rechange. *G.* Wechselventil (n); **suction,** *F.* soupape (f) d'aspiration. *G.* Saugventil (n); **box,** *F.* boîte (f) à clapet. *G.* Ventilkasten (m); **casing,** *F.* chambre (f) du tiroir. *G.* Schieberkasten (m); **chamber,** *F.* chambre (f) des soupapes; des valves. *G.* Ventilkammer (f); **face,** *F.* face (f) de lumi-

ères. *G.* Schieberspiegel (m). *F.* barrette (f). *G.* Ventilfläche (f); **face slide,** *F.* bande (f) plane des tiroirs; bande de frottement. *G.* Schieberfläche (f); **gear,** *F.* renvoi (m) du tiroir. *G.* Schiebersteuerung (f); **gear slide,** *F.* distribution (f) par tiroir plat. *G.* Flachschiebersteuerung (f); **joint, suction,** *F.* douille (f) d'une soupape d'aspiration. *G.* Saugventilstutzen (m); **rod,** *F.* bielle (f) du tiroir. *G.* Schieberstange (f); **seat,** *F.* siège (m) d'une soupape. *G.* Sitz (m) eines Ventils; einer Schieber; **slide,** *F.* soupape (f) du tiroir; soupape (f) glissante. *G.* Schieberventil (n); Schieber (m); **throttle,** *F.* soupape (f) à gorge. *G.* Drosselventil (n). *F.* papillon (m). *G.* Ausströmungsregulator (m). *F.* registre (m) de vapeur. *G.* Drosselklappe (f).

Van, delivery. *F.* voiture (f) de livraison. *G.* Lieferungswagen (m).

Vaporize, to. *F.* vaporiser; Evaporer. *G.* verrauchen; verdampfen.

Variable. *F.* variable. *G.* veränderlich.

Varnish. *F.* laque (f); vernis (m); résine-laque (f); *G.* Lack (m); Firnis (m); **copal,** *F.* vernis (m) de copal. *G.* Kopallack (m); **oil,** *F.* vernis (m) à l'huile. *G.* Olfirnis (m).

Varnish, to. *F.* vernisser. *G.* lackieren. (*See* PAINT.)

Ventilator. *F.* ventilateur (m). *G.* Exhaustor (m).

Vertical. *F.* vertical, le. *G.* senkrecht.

Vibration. *F.* vibration (f); trepidation (f). *G.* Schwingung (f); Zittererung (f).

Vise, hand. *F.* pince (f) à vis. *G.* Feilkloben (m); Schraubenstock (m). *F.* étau (m) à main; **pin,** *F.* ténaille (f) à vis. *G.* Feilkloben (m); Schraubenstock (m).

Volatilize, to. *F.* volatiliser. *G.* verflüchtigen.

Vulcanite. *F.* caoutchouc (m) durci. *G.* Hartgummi (m). (*See* EBONITE.)

Vulcanized. *F.* vulcanisé. *G.* vulkanisiert. (*See* INDIA-RUBBER.)

W

Wagon. *F.* voiture (f); wagon (m). *G.* Wagen (m).

Washer. *F.* rond (m) en cuir; rondelle (f). *G.* Scheibe (f); **india-rubber,** *F.* anneau (m) de gomme. *G.* Kautschukring (m); Gummiring (m); **spring,** *F.* ressort (m) dépression. *G.* Rruckfeder (f).

Waste. *F.* fausse fonte (f). *G.* Fehlguss (m); **pipe,** *F.* tuyau (m) de trop plein. *G.* Überlaufrohr (n).

Water, acidulated. *F.* eau acidulée (f). *G.* Säure Wasser (n); **circulation** (*See* PUMP); **gauge case,** *F.* boîte (f) de l'indicateur d'eau. *G.* Wasserstandsgehäuse (n); **level,** *F.* charge (f) d'eau. *G.*

Wasserhöhe (f). *F.* surface (f) de l'eau. *G.* Wasserspiegel (m); **pipe,** *F.* tuyau (m) à eau. *G.* Wasserrohr (n).

Waterproof. *F.* imperméable. *G.* wasserdicht.

Water-tight. *F.* étanche d'eau. *G.* wasserdicht.

Wear and Tear. *F.* déchet (m). *G.* Abnutzung (f).

Weight. *F.* poids (m). *G.* Gewicht (n); Belastung (f); **maximum,** *F.* poids (m) maximum. *G.* Maximalgewicht (n). *F.* Poids (m). *G.* Gewicht (n) eines Motorrado; **net,** *F.* poids (m) net. *G.* Nettogewicht (n).

Welded Tube. *F.* tuyau (m) soudé. *G.* geschweifste Rohr (n).

Welding. *F.* resoudage (m). *G.* Schweifsen (n).

Wheel. *F.* roue (f). *G.* Red (n); **bevel,** *F.* roue (f) conique. *G.* konische Rad (n); **cog,** *F.* roue (f) endentée. *G.* Zahnrad (n); **driven,** *F.* roue (f) commandée. *G.* Treibrad (n); **fly,** *F.* volant (m). *G.* Schwungrad (n); **hand,** *F.* roue (f) à main; guidon (m). *G.* Handrad (n); **internal spur,** *F.* roue (f) dentée intérieure. *G.* Innenzahnrad (n); **ratchet,** *F.* roue (f) à rochet; rochet (m) d'encliquetage. *G.* Sperrad (n); **spur,** *F.* roue (f) dentée cylindrique; hérisson (m). *G.* Stirnrad (n); **starting,** *F.* roue (f) de distribution. *G.* Steuerrad (n); **worm,** *F.* roue (f) hélice. *G.* Schneckenrad (n).

Wire. *F.* fil (m) de ligne. *G.* Leitungsdraht (m); **binding,** *F.* fil (m) à ligature. *G.* Bindedraht (m); **fusible,** *F.* fil (m) fusible. *G.* Bleisicherung (f); **galvanized iron,** *F.* fil (m) galvanisé. *G.* galvanisierte Eisendraht (m); **platinum,** *F.* fil (m) de platine. *G.* Platindraht (m); **primary,** *F.* fil (m) inducteur. *G.* primäre Draht (m); **secondary,** *F.* fil (m) secondaire. *G.* Nebendraht (m).

Wires, insulated. *F.* fils isoles (m). *G.* besponnene Draht (m).

Wood, screw for. *F.* vis (f) pour bois. *G.* Holzschraube (f); **soft,** *F.* bois (m) doux. *G.* Weichholz.

Working Pieces. *F.* parties (f) de mouvement. *G.* Betriebsteile (m).

Worm and Wheel. *F.* engrenage (m) à vis sans fin. *G.* Schneckengetriebe (n).

Worm-wheel, tooth of a. *F.* dent (f) hélicoide. *G.* Zahn (m) eines Schraubenrades.

Wrench, universal screw. *F.* clef (f) anglaise. *G.* englische Schraubenschlüssel (m).

Wrought-iron Tube. *F.* tuyau (m) en tôle. *G.* schmiedeiserne Röhre (f).

Z

Zinc. *F.* zinc (m). *G.* Zink (n).

Zinc Sheet. *F.* zinc (m) laminé; feuille (f) de zinc. *G.* Zinkblech (n).

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WIT, SPARKLING, SCINTILLATING WIT, IS THE ESSENCE OF

Kate of Kate Hall,

By ELLEN THORNEYCROFT FOWLER,

whose reputation was made by her first book, "Concerning Isabel Carnaby," and enhanced by her last success, "Place and Power."

"In 'Kate of Kate Hall,' by Ellen Thorneycroft Fowler, the question of imminent concern is the marriage of super-dainty, peppery-tempered Lady Katherine Clare, whose wealthy godmother, erstwhile deceased, has left her a vast fortune, on condition that she shall be wedded within six calendar months from date of the testator's death.

"An easy matter, it would seem, for bonny Kate, notwithstanding her aptness at sharp repartee, is a morsel fit for the gods.

"The accepted suitor appears in due time; but comes to grief at the last moment in a quarrel with Lady Kate over a kiss bestowed by her upon her godmother's former man of affairs and secretary. This incident she haughtily refuses to explain. Moreover, she shatters the bond of engagement, although but three weeks remain of the fatal six months. She would rather break stones on the road all day and sleep in a pauper's grave all night, than marry a man who, while professing to love her, would listen to mean and malicious gossips picked up by tell-tales in the servants' hall.

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"The long-standing reproach that women are seldom humorists seems in a fair way of passing out of existence. Several contemporary feminine writers have at least sufficient sense of humor to produce characters as deliciously humorous as delightful. Of such order is the Countess Claverley, made whimsically real and lovable in the recent book by Ellen Thorneycroft Fowler and A. L. Felkin, 'Kate of Kate Hall.'"—*Chicago Record-Herald.*

"'Kate of Kate Hall' is a novel in which Ellen Thorneycroft Fowler displays her brilliant abilities at their best. The story is well constructed, the plot develops beautifully, the incidents are varied and brisk, and the dialogue is deliciously clever."—*Rochester Democrat and Chronicle.*

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